INSTRUCTION MANUAL

SERIES LX-2

DIGITAL MULTI-FUNCTION METER

NON-LINEAR SYSTEMS, INC.

DEL MAR, CALIFORNIA

NOTICE

If at any time it should become necessary to return an NLS instrument to the factory, follow the instructions contained in the Appendix of this manual (page A-1) and utilize NLS Form No. 200-50 (Shipping Notice/Packing Slip), located at the rear of the manual.

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February 1972

INSTRUCTION MANUAL

SERIES LX-2

DIGITAL MULTI-FUNCTION METER

LX-2
P/N 35-1 shown

Originator of the Digital Voltmeter

non-linear systems, inc.

DEL MAR (SAN DIEGO), CALIFORNIA

Printed in the United States of America

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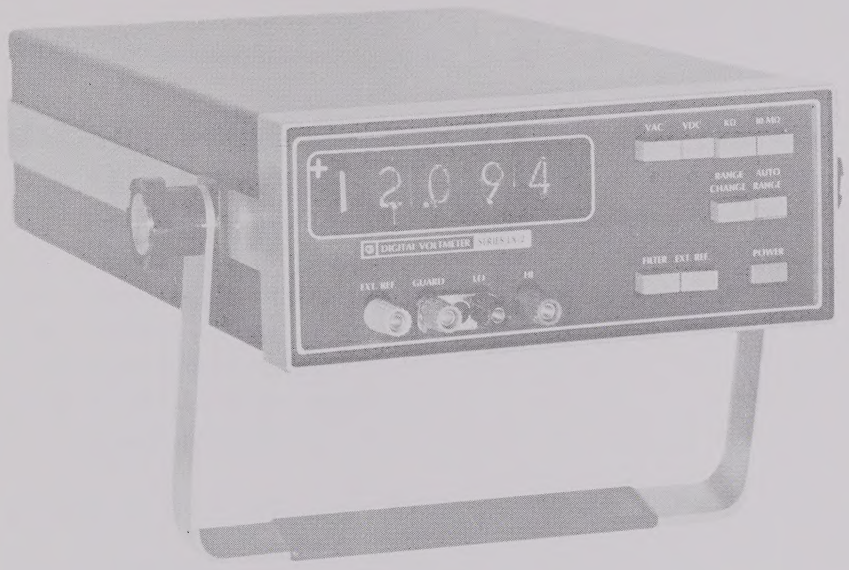

Automatic and Manual Ranging LX-2A P/N 35-2

SUPPLEMENT I

The Model LX-2A Digital Multi-Function Meter (P/N 35-2) differs from the Series LX-2 DVM (P/N 35-1), described in this manual, in the following respects:

1. An AUTO RANGE switch and a RANGE CHANGE switch have been added to the front panel of the instrument.

   a. To utilize the auto-ranging capability of the instrument, depress the AUTO RANGE pushbutton switch.

   b. To manually select a range, release the AUTO RANGE switch; note the position of the decimal point. Press the RANGE CHANGE pushbutton switch as required to reach the desired range.

2. A power-selection switch has been added to the rear of the instrument.

   a. The unit is shipped from the factory with this switch in the "115" position and a 0.5 ampere fuse installed.

   b. If it is desired to operate from a 230 VAC power source, change the fuse to 0.25 ampere and move the selection switch to the "230" position.

3. Utilize Schematic Diagram 35-92 for the LX-2A Main Board Assembly and Schematic Diagram 35-93 for the LX-2A Function Switching Assembly.

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Drawing No.	Title
35-24	Function Switching Assembly
35-32	Main Board Assembly

CHAPTER I

INTRODUCTION AND SPECIFICATIONS

1-1. GENERAL DESCRIPTION

1-2. The NLS Series LX-2 is a four-digit Multifunction meter with automatic range and polarity selection. The instrument measures DC voltage in four ranges, AC voltage in four ranges, resistance in four + one ranges and has external reference capability in all functions and ranges. Twenty percent over-ranging is provided in most ranges and functions (See specifications for exceptions). The instrument may be used as a bench model or, with the use of rack-mounting adapters, may be rack-mounted in a standard 19-inch mounting rack.

1-3. OPTIONAL ACCESSORIES

1-4. Accessories available for the Series LX-2 are:

Data Output
Rechargeable Battery Pack
Rack-Mounting Kit
High Voltage Probe
Current Shunts
Input Cable

1-5. OPERATING PRINCIPLE

1-6. In these instruments, the unknown input is isolated and used to charge a capacitor during a specific time interval. An internal reference is then applied to discharge the capacitor. Measuring the time interval required to discharge the capacitor indicates the unknown input.

1-7. DATA OUTPUT OPTION

1-8. The instrument possesses a printout and remote triggering capability (8-4-2-1 BCD) for operation with Data Printers, Tape Punches, Typewriters, and other recording devices.

1-9. BATTERY OPTION

1-10. A rechargeable battery power pack, housed inside the instrument's case, provides more than six hours of operation, free of main power lines. The power pack "floats" on line under normal operation maintaining the batteries at full charge. A front panel recharge indicator light provides an instantaneous display of low charge state.

1-11. INPUT CONNECTIONS

1-12. For maximum flexibility, the instrument has an isolated chassis (connected to the third pin of the power plug) and four input terminals - Signal HI, Signal LO, EXT. REF. and GUARD. This allows the user isolation from common ground, permits the internal guard shielding to be connected to external common-mode voltages, reducing common-mode effects and permits isolated input signal leads. See specifications for allowable voltages between input terminals.

1-13. COMMON-MODE-REJECTION

1-14. Rejection of common-mode signals, those caused by AC or DC currents flowing between signal source ground and instrument chassis ground, is a feature of the Series LX-2 DVM. (To obtain the highest common-mode-rejection, the shorting strap between Signal LO and GUARD should be removed and the GUARD terminal connected to the common-mode signal source. Common-mode signal rejection is important in a wide range of applications - testing complex electrical

and electronic systems, in automatic measuring systems, and measuring outputs from thermocouples, strain gages and other transducers where common-mode signals may be many times greater than the measured DC. voltage.

SPECIFICATIONS

MODE	RANGE	30 DAY ACCURACY	RESOLUTION	TEMPERATURE COEFFICIENT	INPUT RESISTANCE
Volts DC	1. 1999 11. 999 119. 99 1000. 0	ASA Reference Conditions ±(0. 02% Rdg + 0. 008% FS)	100 μV 1 mV 10 mV 100 mV	±(0. 0025% Rdg + 0. 0008% FS)/°C	10 MΩ
Volts AC	1. 1999 11. 999 119. 99 1000. 0	50 Hz to 10 KHz; Usable, (30 Hz to 20 KHz - Slight degradation of accuracy) ±(0. 1% Rdg + 0. 04% FS)	100 μV 1 mV 10 mV 100 mV	±(0. 01% Rdg + 0. 0016% FS)/°C	1 MΩ, < 100pF
KΩ	1. 1999 11. 999 119. 99 1250. 0	±(0. 02% Rdg + 0. 008% FS)	100 MΩ 1 Ω 10 Ω 100 Ω	±(0. 0035% Rdg + 0. 0012% FS)/°C	Test Voltage -17V across open input 1. 2V at FS
10^4 KΩ (10 MΩ) Manual	12500	±(0. 05% Rdg + 0. 008% FS)	1000 Ω	±(0. 0035% Rdg + 0. 0012% FS)/°C	1. 25V at FS
EXT. REF. (+8 to +10. 5V)	Selecting this mode does not change the input conversion properties of the instrument with respect to decimal location, range selection, accuracy or resolution			±0. 0025% Rdg + 0. 0008% FS)/°C + T. C. of above mode selected	> 10 MΩ

MAXIMUM INPUT VOLTAGES	
Signal Hi to Signal Lo	VDC: ±1000V Peak VAC: ±1500V Peak with no more than 600 VDC component KΩ: ±300V Peak 10^4 KΩ (10 MΩ): ±1000V Peak
Ext. Ref. to Signal Lo	All Functions and Ranges: ±50V Peak
Signal Lo to Guard	All Functions and Ranges: ±100V Peak
Guard to Chassis	All Functions and Ranges: ±500V Peak

LIST OF SCHEMATIC DIAGRAMS

Drawing No.	Title
35-24	Function Switching Assembly
35-32	Main Board Assembly

CHAPTER II

INSTALLATION AND OPERATION

2-1. UNPACKING

2-2. The instrument is shipped in a heavy cardboard container. Cut the tape on the top of the container and open. If damage is observed, promptly notify the carrier. Immediately check the packing slip for possibility of shortages.

2-3. POWER SOURCE

2-4. The instrument is usually supplied for operation from 105-125-volt, 50-400 Hz, single phase power sources. However, the instrument will operate from 210-250-volt, 50-400 Hz, single phase sources if the two primaries of the power transformer are wired in series instead of parallel.

2-5. The LX-2 may be operated from an internal rechargeable battery pack if equipped with the battery option. The batteries charge automatically when the instrument is connected to the power line and turned on. Removing the power cord from the power line places the instrument in battery mode.

2-6. FUSING

2-7. The instrument is protected by a 3AG 1/2 ampere Slo-Blo fuse (F1) which is located adjacent to the power transformer.

2-8. When a 210-250-volt power source is to be used (and the power transformer primary rewired as indicated above). it is recommended that a 1/4 ampere Slo-Blo fuse be used to provide maximum protection. An 8AG 1/100 ampere fuse is used to protect the ohmmeter circuitry against application of external voltages. This fuse is located on the function switching assembly.

The rechargeable battery option incorporates a 3AG 4 ampere Slo-Blo fuse which is located on the converter board.

2-9. POWER GROUNDING

2-10. The third pin of the power plug grounds the outer chassis of the instrument (Figure 2-1). Despite the presence of the third grounding pin, there is no real assurance that the instrument will be corrrctly connected since the power outlets in many installations are erroneously wired. Be certain that the power source is in agreement with the power and grounding requirements of the instrument.

2-11. CONNECTORS (Figure 2-2)

2-12. Four input connectors are located on the front panel of the instrument. They are color-coded and labeled as to function:

Signal HI	Red
Signal LO	Black
Guard	Blue
External Reference	Yellow

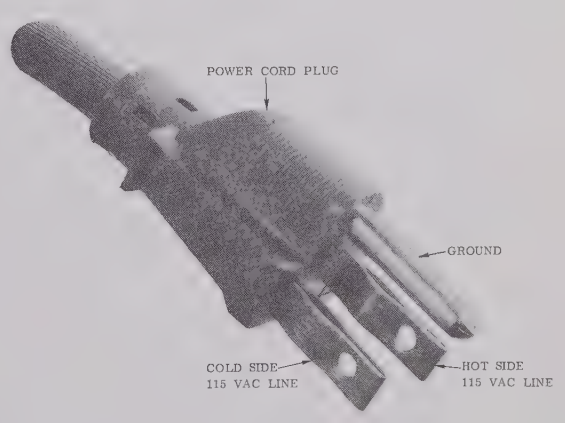


Figure 2-1. Power Plug Pin Coding

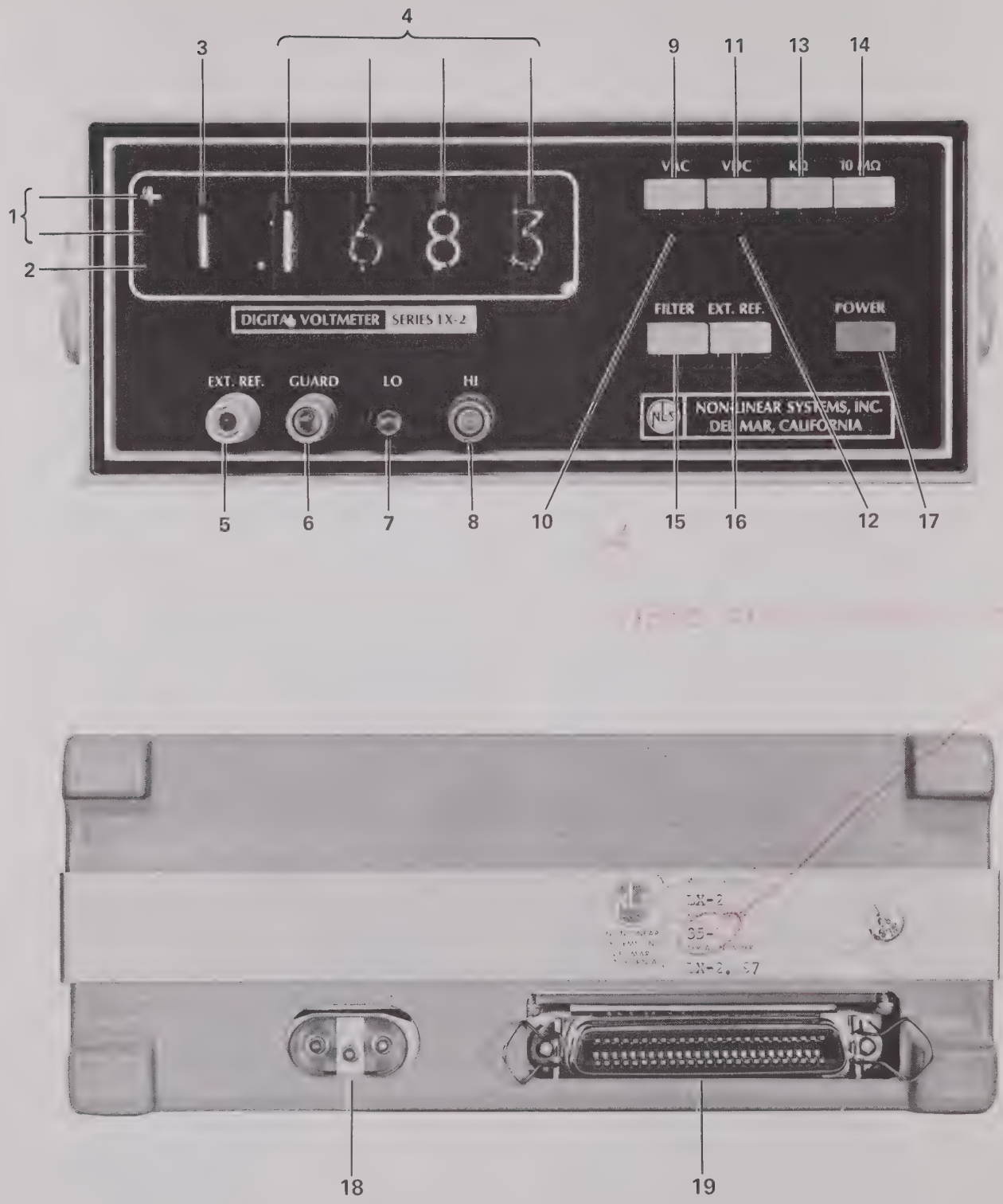


Figure 2-2. Front and Rear Views

REF	TITLE	DESCRIPTION
1	Polarity Indicators	Incandescent bulbs behind mask indicate polarity of DC voltage applied to HI terminal with respect to LO terminal in VDC mode.
2	Battery Lo Indicator	Incandescent bulb behind mask indicates that the batteries have insufficient charge to properly power the instrument when the battery option is installed and the instrument is being operated from the batteries. This indicator also turns on when the line voltage is too low and the battery option is installed.
3	Over-range Indicator	Neon bulb displays over-range "1" corresponding to 10,000 digits.
4	Readout Tubes	Gas discharge display tubes which provide the readout in decimal form. There are four plug-in tubes, each containing the numerals 0 thru 9 and a decimal point.
5	External Reference Terminal	Input connection for external reference voltage. The external reference voltage must have a common connection with the input signal being measured. Acceptable voltage range applied this terminal is +8 volts to +10.5 volts.
6	Guard Terminal	Connects to inner guard shield. This terminal must always be connected either to signal LO by the shorting strap provided or to a source of common-mode voltages to provide increased rejection of common-mode signals.
7	Signal LO Terminal	Connects to instrument signal common. All measurements are made with respect to this terminal.
8	Signal HI Terminal	Connects to instrument signal input. All measurements are made of the voltage or resistance applied to this terminal.
9	VAC Switch	Push button switch selects AC voltage measurements. Button "in" indicates readout is displaying AC volts (AC converter is average responding, calibrated in RMS).
10	AC Zero	Front panel zero control which will adjust the readout to 0.000 VAC when signal HI and LO are shorted together (DC zero should be checked first).
11	VDC Switch	Push-button switch selects DC voltage measurement. Button "in" indicates readout is displaying DC volts, including polarity.
12	DC Zero	Front panel zero control which will adjust the readout to ±0.000 VDC when signal HI and LO are shorted together.
13	KΩ Switch	Push-button switch selects KΩ resistance measurement. Button "in" indicates readout is displaying kilohms.
14	10^4KΩ (10MΩ) Switch	Push-button switch selects KΩ resistance measurement above 1.25 megohms. Button "in" indicates readout is displaying kilohms with the decimal understood to be to the right of the least significant digit.
15	Filter Switch	Push on-push off switch controls the amount of input filtering and the reading rate of the instrument. Button "in" provides increased filtering and slower reading rate.
16	External Reference Switch	Push on-push off switch selects external reference voltage or internal reference voltage. Button "in" indicates measurement is made using the voltage applied to the EXT. REF. terminal (See Figure 2-3 for calibration of reading). Button "out" indicates readout is displaying absolute units as described in References 9, 11, 13 and 14 of this Table. Application of voltage to EXT. REF. terminal does not affect calibration of instrument until EXT. REF. button is "in".
17	Power Switch	Push on-push off switch controls main power to instrument. Button "in" turns instrument on.
18	Power Connector	Three-pin connector accepts power from AC line source.
19	Output Connector	Fifty-pin connector (optional) provides transfer of measurement data to external recording device.

Figure 2-2. Front and Rear Views (Sheet 2 of 2)

2-13. A 3-pin AC connector is located on the rear panel of the instrument and mates with the line cord termination.

2-14. Instruments purchased with the optional data output feature will have a 50-pin connector also located on the rear panel.

2-15. CONTROLS AND DISPLAYS

2-16. See Figure 2-2 (Sheets 1 and 2).

2-17. OPERATION

1. Plug proper end of power cord into rear of instrument and other end into a 115 VAC, 50-400 Hz power source. (If the optional battery pack is being used for the first time, it may be necessary to plug instrument into the power line and turn instrument on for at least 8 hours to charge the batteries - it can take up to 16 hours to fully charge a set of fully discharged batteries).
2. Connect the guard terminal with the LO terminal using the shorting strap provided.
3. Connect input leads to Signal Hi and Signal Lo terminals. (Lead resistance should be less than 0.1Ω to avoid measurement errors.)
4. Switch instrument on by depressing power push button.

2-18. MEASURING DC VOLTS

1. Switch into DC volts mode by depressing VDC button. Ensure that EXT. REF. button is in the "out" position.
2. Short circuit input leads - readout should register 0.000. (If necessary, the readout may be zeroed by readjusting the zero adjust control with a small screwdriver inserted in hole directly under VDC button.)
3. DC volts may be measured by connecting input leads to voltages of interest. The instrument will select the proper range automatically, displaying the voltage, decimal point and polarity of the input HI terminal with respect to the input LO terminal.
4. Depressing the filter button, switches in a filter, increasing the instruments ability to reject noise. Using the filter decreases the speed per reading from 0.5 second to 1 second.
5. High voltage measurements, between 1 KV and 30 KV may be made with the use of the optional probe which provides an attenuation of 1,000:1.

2-19. MEASURING AC VOLTS

1. Switch into AC volts mode by depressing VAC button.
2. Short circuit input leads - readout should register 0.000. (If necessary, the readout may be zeroed by readjustment of the AC zero adjust control with a small screwdriver inserted in the hole directly beneath the VAC button.
3. AC volts may be measured by connecting input leads to AC voltages of interest. The instrument will select the proper range automatically, displaying AC voltage and decimal point.

2-20. MEASURING RESISTANCE

1. Switch into Kohms mode by depressing KΩ button.
2. Short circuit input leads - readout

should register 0.000KΩ. If the readout does not display 0.000KΩ, recheck the DC zero (paragraph 2-18, step 2). If the DC zero is properly set, then the meter is displaying the resistance of the test leads. For best accuracy, test leads should be used with a series resistance of less than 0.1Ω. However, reading accuracy may be maintained if the test lead resistance measured by the instrument is subtracted from the reading taken on an unknown resistor; i.e. test lead reading = .0020KΩ, unknown reading = 9.675KΩ, compensated reading = 9.675 - .002 = 9.673KΩ.

3. Resistance may be measured by connecting the input leads to the unknown resistance. The instrument will select the proper range automatically displaying the resistance in KΩ and the decimal point.

4. To make measurements in the 10MΩ range, depress the 10^4KΩ (10MΩ) button. The instrument will display the resistance in KΩ with the decimal point understood to be to the right of the least significant digit, but not actually displayed; i.e. 12500KΩ.

NOTE

The test configuration used is two-wire constant current. The test currents are: 1K range - 1mA, 10K range - 100μA, 100K range - 10μA, 1000K range - 1μA, 10,000KΩ range - 100nA. The polarity of the test voltage across the unknown resistor is negative at the Signal HI terminal with respect to the Signal LO terminal.

2-21. OPERATION WITH AN EXTERNAL REFERENCE

1. Connect an external reference voltage from +8 to +10.5V between the EXT. REF. and LO terminals.

2. Switch into external reference mode by depressing the EXT. REF. button.

3. The instrument will now display the ratios of input to external reference. (See Figure 2-3.)

BUTTONS DEPRESSED	READING DISPLAYED
VDC and EXT. REF.	$10 \times \frac{\pm\text{Input VDC}}{\text{Ref. VDC}}$
VAC and EXT. REF.	$10 \times \frac{\text{Input VAC}}{\text{Ref. VDC}}$
KΩ and EXT. REF.	$10 \times \frac{\text{Input K}\Omega}{\text{Ref. VDC}}$
10^4KΩ (10MΩ) and EXT. REF.	$10 \times \frac{\text{Input K}\Omega}{\text{Ref. VDC}}$

Figure 2-3. Ratio Reading Calibration

CHAPTER III

THEORY OF OPERATION

3-1. INTRODUCTION

3-2. The LX-2 electronics may be divided into two basic sections, a Signal Conditioning Section and a Digitizing Section. The Signal Conditioning Section processes resistance measurements and DC and AC voltage inputs into a normalized DC analog signal. The Digitizing Section accepts the normalized DC analog signal.

3-3. Subdivisions within this chapter describe the various circuits making up each section. An overall block and logic diagram is shown in Figure 3-1.

3-4. SIGNAL CONDITIONING SECTION

3-5. In order to provide a normalized DC analog signal to the Digitizing Section, it is necessary to convert AC and resistance measurements to DC which can then be digitized. Since the input signal is compared with an internal reference, it is necessary to attenuate input signals greater than the internal reference. The input attenuator and signal conditioning for DC, AC and resistance measurement will be discussed in paragraphs 3-6 thru 3-15.

3-6. SIGNAL CONDITIONING FOR VOLTS DC (Figure 3-2)

3-7. The volts DC mode has four ranges; 1.1999, 11.999, 119.99 and 1000V full scale. The auto-range attenuator is set to the proper range by logic circuits which actuate the range relays. The attenuator output is voltage-limited by a protective circuit to no more than + or - 3 VDC so that the filter and amplifier will recover quickly from overloads. The attenuator output feeds a filter which attenuates unwanted AC signals and noise. Additional filtering may be switched on by use of a front-panel switch. The output of the filter is applied to the buffer-amplifier, Q57 and A20. Q57 is a dual F.E.T. low noise, low drift, high input impedance device which drives A20, a monolithic operational amplifier; the combination provides an open loop gain of about 3×10^6.

3-8. The output of A20 is connected through a diode bridge and then returns to Q57, completing a negative feedback loop, making Q57-A20 a combination input buffer, polarity inverter and integrating amplifier. The diode bridge functions to charge capacitors C25 thru C28 in the same direction regardless of signal polarity at the input terminals. The charge on these capacitors is the normalized DC analog signal. Since the output of the buffer-amplifier may be of either polarity, it is used to actuate circuitry which will indicate polarity by lighting DS3 or DS4.

3-9. SIGNAL CONDITIONING FOR VOLTS AC (Figure 3-3)

3-10. The volts AC mode has four ranges; 1.1999, 11.999, 119.99 and 1000V full scale. Depressing the VAC push button connects the SIG Hi terminal to the AC volts signal conditioning circuits and switches the DC output of these circuits to the input of the DC signal conditioning circuits. AC signals are connected to C10, R39, CR5, and CR6, and the input of amplifier A1. C10 blocks DC, allowing AC to pass. R39 and CR5 and CR6 act as a voltage-limiting circuit protecting the input to amplifier A1. A1 is a monolithic operational amplifier in a negative feedback loop.

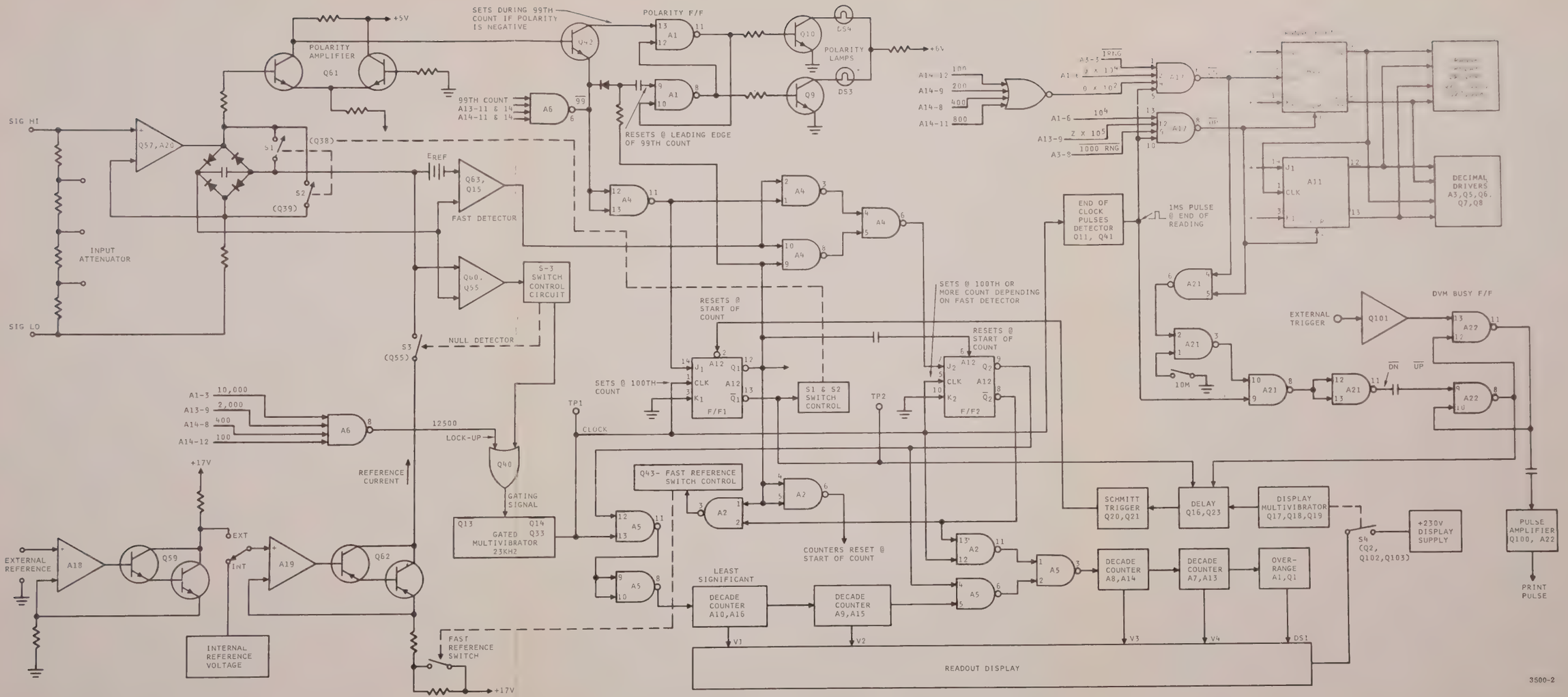


Figure 3-1. Logic Diagram - Series LX-2 DVM

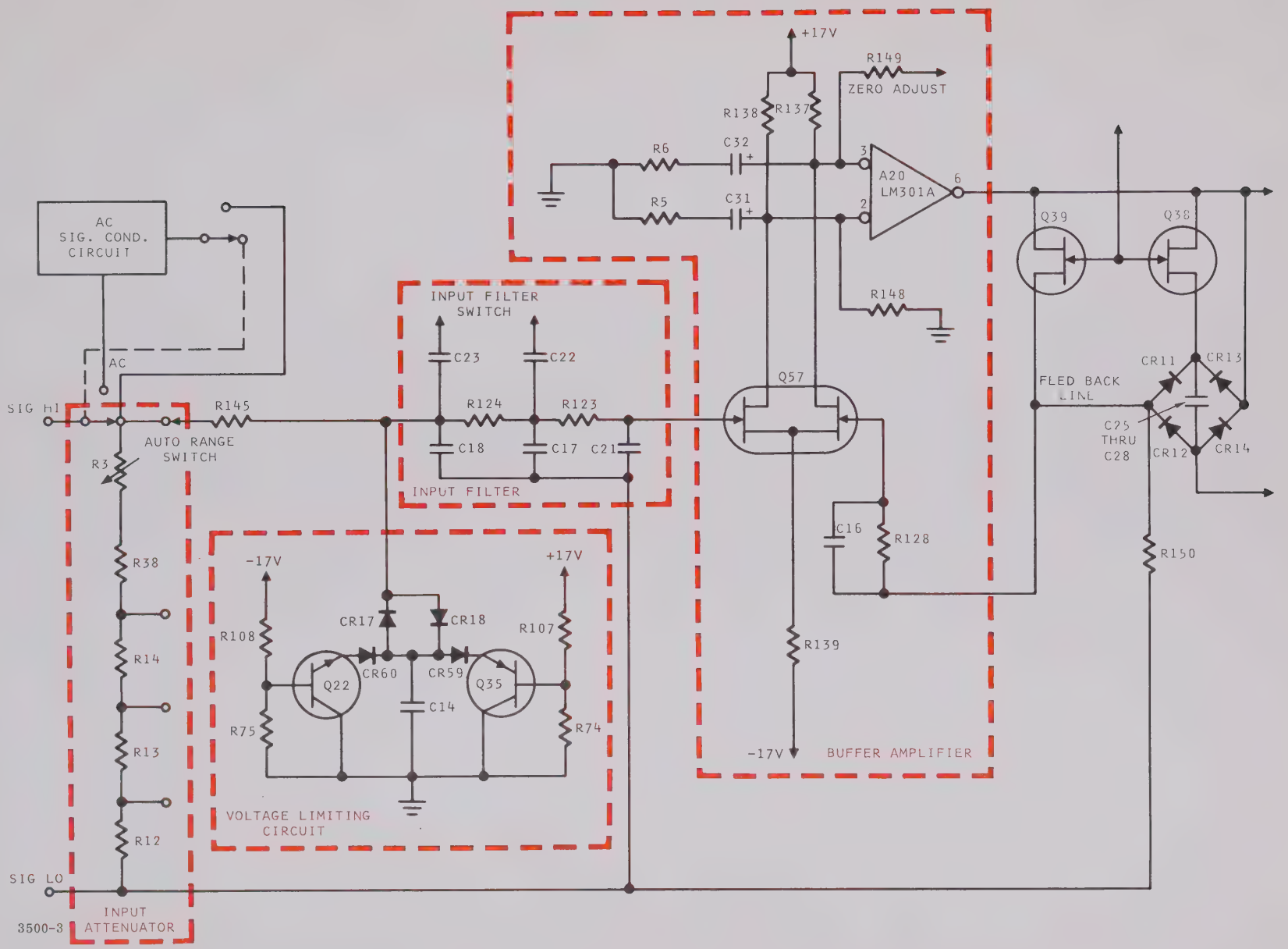


Figure 3-2. Simplified Diagram - Input Attenuator and DC Volts Signal Conditioning Circuits

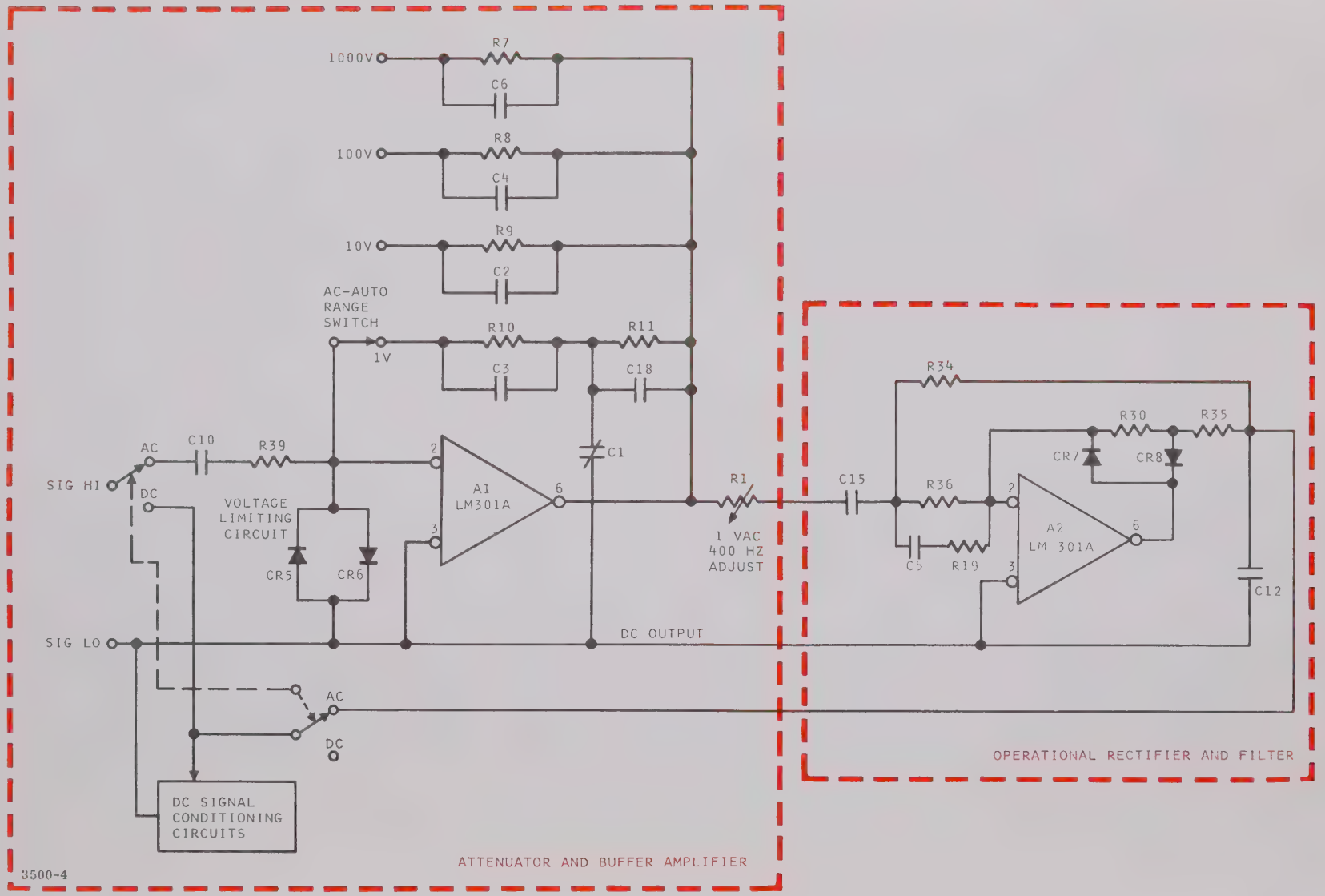


Figure 3-3. Simplified Diagram - AC Volts Signal Conditioning Circuits

The gain of A1 is determined by the ratio of the input resistor R39 to R7, through R11. The output of A1 goes through R1, a calibration adjustment, coupling capacitor C15 and input resistor R36 to the input of A2, a second operational amplifier. Diodes CR7 and CR8, placed inside the negative feedback loop around A2, form an operational full-wave rectifier, whose DC output is filtered by R34, R35 and C12. In the AC volts mode, range attenuation is accomplished by switching feedback resistors R7 thru R11 around A1. As in the DC volts mode, this is done automatically by the logic circuits which actuate the proper relays. To compensate for losses in rectification and filtering, A1's normal range attenuation is reduced by one-half and A2 has a gain of 2X.

3-11. SIGNAL CONDITIONING FOR RESISTANCE MEASUREMENT (Figure 3-4)

3-12. The KΩ mode has four ranges; 1.1999, 11.999, 119.99 and 1250.0KΩ. An additional manually selected range of 10^4KΩ (10 megohms) provides a display of 12500KΩ. Resistance measurements are made by measuring the voltage drop across a resistance under test (R_X) through which a known stable current is passing. To read the proper value, current passing through R_X must be proportioned so that one unit of the resistance being measured is equal to one digit displayed in the readout. This requires precise current steps when switching from range to range (four lower ranges).

3-13. A constant current supply and regulator circuit incorporating Q1, Q2, Q3 and Q6 forms the precision current source. The instrument's internal reference supply is used as a reference voltage for the constant current supply. The buffer-amplifier feedback voltage is used to maintain a constant current through R_X, compensating for differing values of R_X.

3-14. A 1/100A fuse is used to protect the regulator current from inadvertant contact with voltage sources when in the KΩ or 10^4KΩ modes.

3-15. In the KΩ measuring mode, the DC input attenuator is connected between the constant current supply and R_X. The attenuator now becomes a series of precision resistors which is switched by the logic circuits, forming an auto-ranging ohmmeter in these four lower ranges.

3-16. DIGITIZING SECTION (Figure 3-5)

3-17. The Digitizing Section functions to accept the normalized DC analog signal and process it so that it may be displayed digitally with the proper decimal and polarity signs.

3-18. The Digitizing Section contains two multivibrators which generate timing periods and clock pulses. Basic timing of the instrument is set by the Display Timer, a 50 Hz/sec multivibrator which produces an assymetrical 4-mSec - 20-mSec rectangular waveform. During the 4-mSec period, the readout lamps are illuminated, displaying the instrument's reading. The end of the 4-mSec period triggers on the digitizing period which lasts for 20 mSec. At the instant the digitizing period starts, the counters are reset, the 23K Hz clock multivibrator is gated on and applied to the counters. The buffer-amplifier output is gated, allowing C25 thru C28 to charge. At the end of 100 clock pulses, the counters are reset, C25 thru C28 are switched to a constant current reference source which discharges the capacitors at a specific rate. Level sensing circuits determine whether a "Fast" or "Slow" discharge rate is to be switched in. The "Fast" rate is automat-

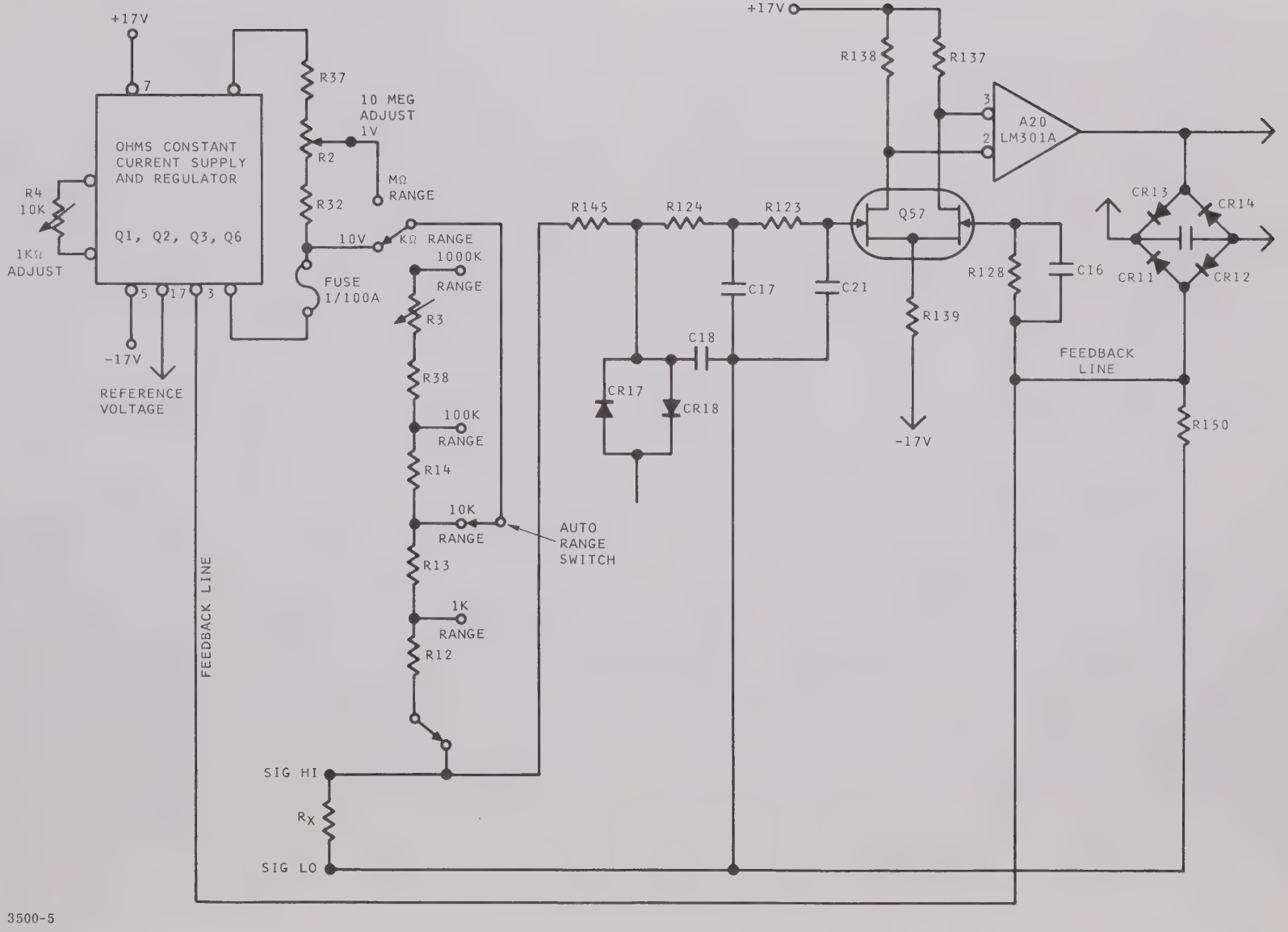


Figure 3-4. Simplified Diagram - Resistance Measuring Signal Conditioning Circuits

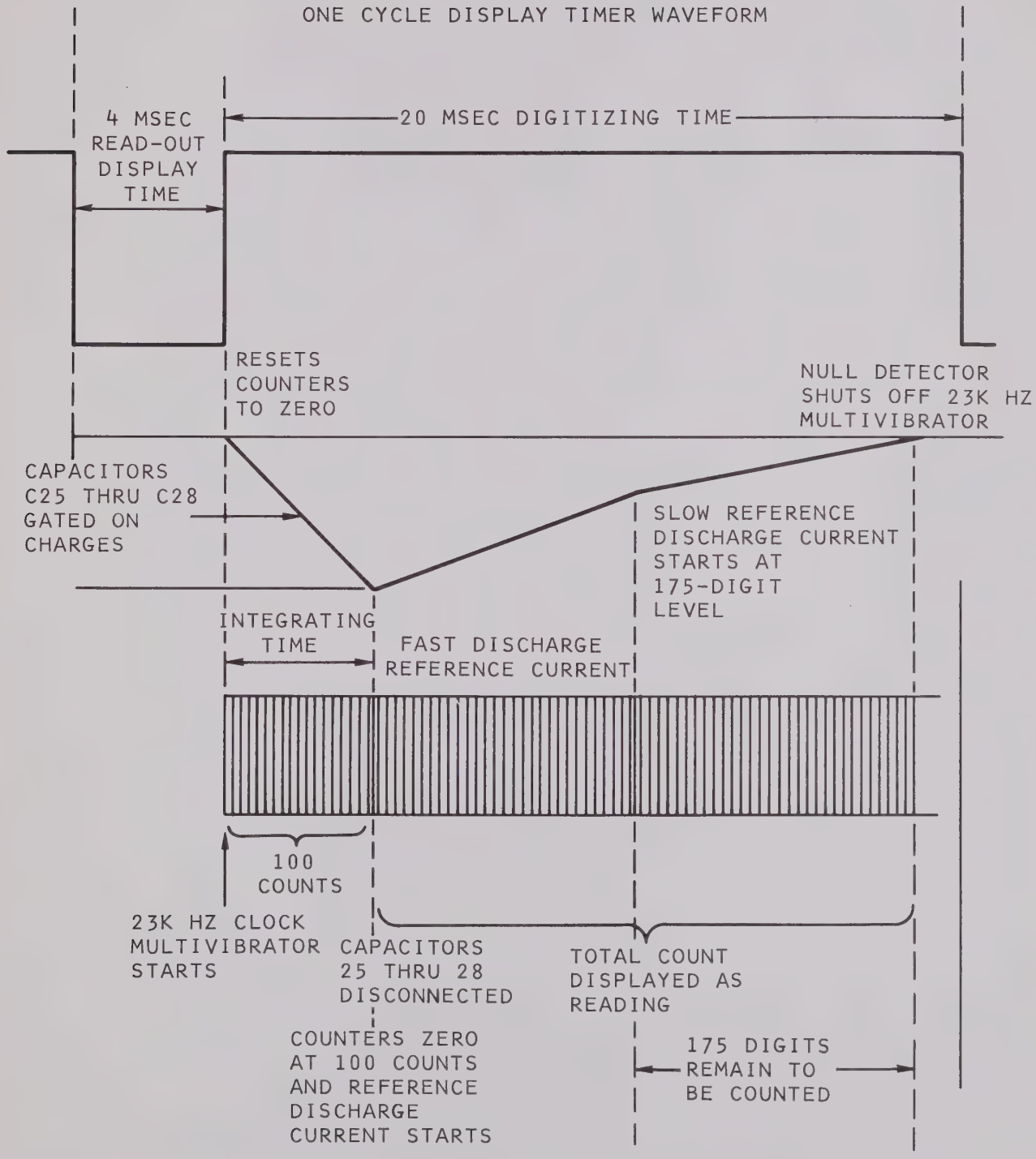

ONE CYCLE DISPLAY TIMER WAVEFORM
4 MSEC READ-OUT DISPLAY TIME
20 MSEC DIGITIZING TIME
RESETS COUNTERS TO ZERO
NULL DETECTOR SHUTS OFF 23K HZ MULTIVIBRATOR
CAPACITORS C25 THRU C28 GATED ON CHARGES
SLOW REFERENCE DISCHARGE CURRENT STARTS AT 175-DIGIT LEVEL
INTEGRATING TIME
FAST DISCHARGE REFERENCE CURRENT
100 COUNTS
23K HZ CLOCK MULTIVIBRATOR STARTS
CAPACITORS 25 THRU 28 DISCONNECTED
TOTAL COUNT DISPLAYED AS READING
COUNTERS ZERO AT 100 COUNTS AND REFERENCE DISCHARGE CURRENT STARTS
175 DIGITS REMAIN TO BE COUNTED
3500-6

Figure 3-5. Digitizing Section - Preliminary Discussion

ically switched to the "Slow" rate when about 175 digits remain to complete the reading. When the capacitors have discharged to the same level as when the digitizing period began, the Null Detector circuit shuts off the clock multivibrator.

3-19. The counters have counted a specific number of clock pulses during the discharge period, have set the decoding circuits, which have applied proper potential on the readout numerals, and the arrival of the 4-mSec display pulse illuminates the readout lamps with a digital display equal to the analog voltage.

3-20. DIGITIZING SECTION - CIRCUIT DESCRIPTION

3-21. Display Timer. Basic timing for the digitizing circuits is developed from the Display Timer Multivibrator circuit (Figure 3-6). Q17 and Q18 with the associated circuitry forms a 50 Hz/sec rectangular pulse generator with a 4-mSec pulse width and a 20-mSec recovery period. Q19 reduces loading on Q17 and Q18 and provides a low impedance path to Q102 which drives Q103 and Q2. This pair acts as a 4-mSec high voltage switch, pulsing the readout lamps.

3-22. Q19 also feeds Q16. Normally, Q16 feeds negative pulses to the Schmitt trigger, Q20-Q21. Under some conditions, such as auto-ranging, input filtering, etc., it is necessary to delay the digitizing circuits. This is done by Q23 which controls the charge on C35 which in turn sets the voltage level at the collector of Q16, thereby controlling the amplitude of the pulses that drive Schmitt trigger Q20-Q21. Insufficient pulse amplitude will inhibit Q20-Q21.

3-23. Integrating Time (Figure 3-7). The output of Schmitt trigger Q20-Q21 pulses pin 2 of Flip-Flop A12, resetting it and initiating the digitizing period. The following events occur when Flip-Flop A12 changes state:

(A) The voltage change at pin 12 of A12 is differentiated thru C5 and amplified by A2. The resultant pulse at pin 6 zeros the counters.

(B) The voltage change at pin 13 of A12 is coupled thru R51 to Q51 and Q44 which gates off Q38 and Q39, allowing the integrating capacitors C25 thru C28 to charge.

(C) Q51 also drives Q46, Q45 and Q40 which allows the clock multivibrator, Q13 and Q14 to start.

(D) Clock pulses from Q33 go to A2, whose output connects to A5, which drives counter A14.

(E) During the next part of the digitizing interval, counters A13 and A14 proceed to count clock pulses while the intergrating-capacitors charge from the buffer-amplifier. At the count of 99, the combined counter outputs gate A6. Gated A6 output (pin 6) drives A4 which changes the state of Flip-Flop A12 at the 100th clock pulse. The following events occur at the 100th clock pulse:

1. Counters A13 and A14 cycle to zero.

2. Q38 and Q39 switch on, connecting the integrating capacitors to the "Slow" reference discharge current.

3. Level sensing circuits determine the magnitude of the signal on the integrating capacitors. If an input of 175 digits or more is present, the "Fast" reference discharge becomes operative, making the discharge rate 100 times faster then the "Slow" rate.

4. In the "Slow" discharge mode, clock pulses are fed to pin 14 of A14. In the "Fast" discharge mode, clock pulses are fed to pin 14 of A16.

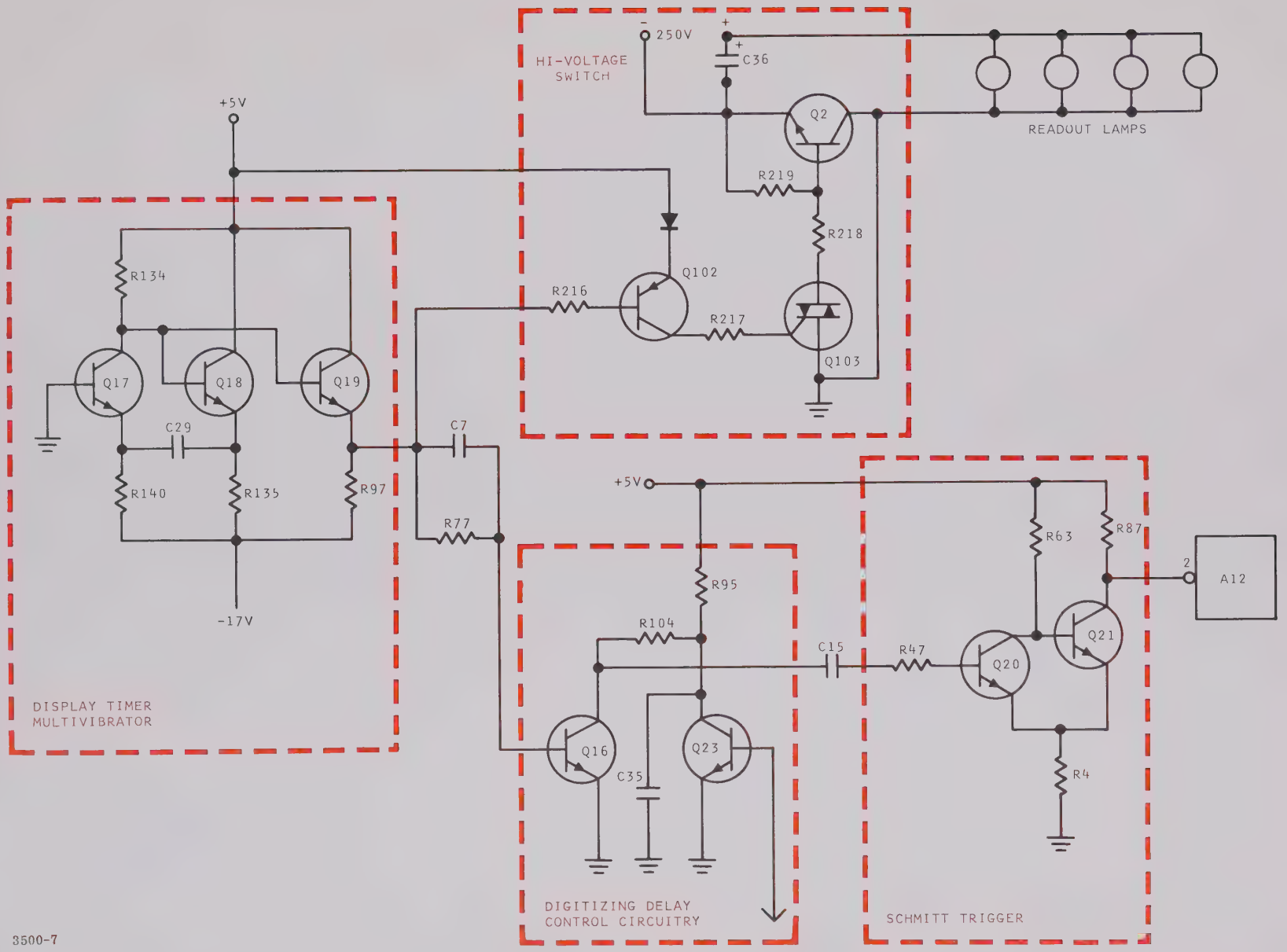


Figure 3-6. Simplified Diagram - Display Timer, Delay Control and High Voltage Circuits

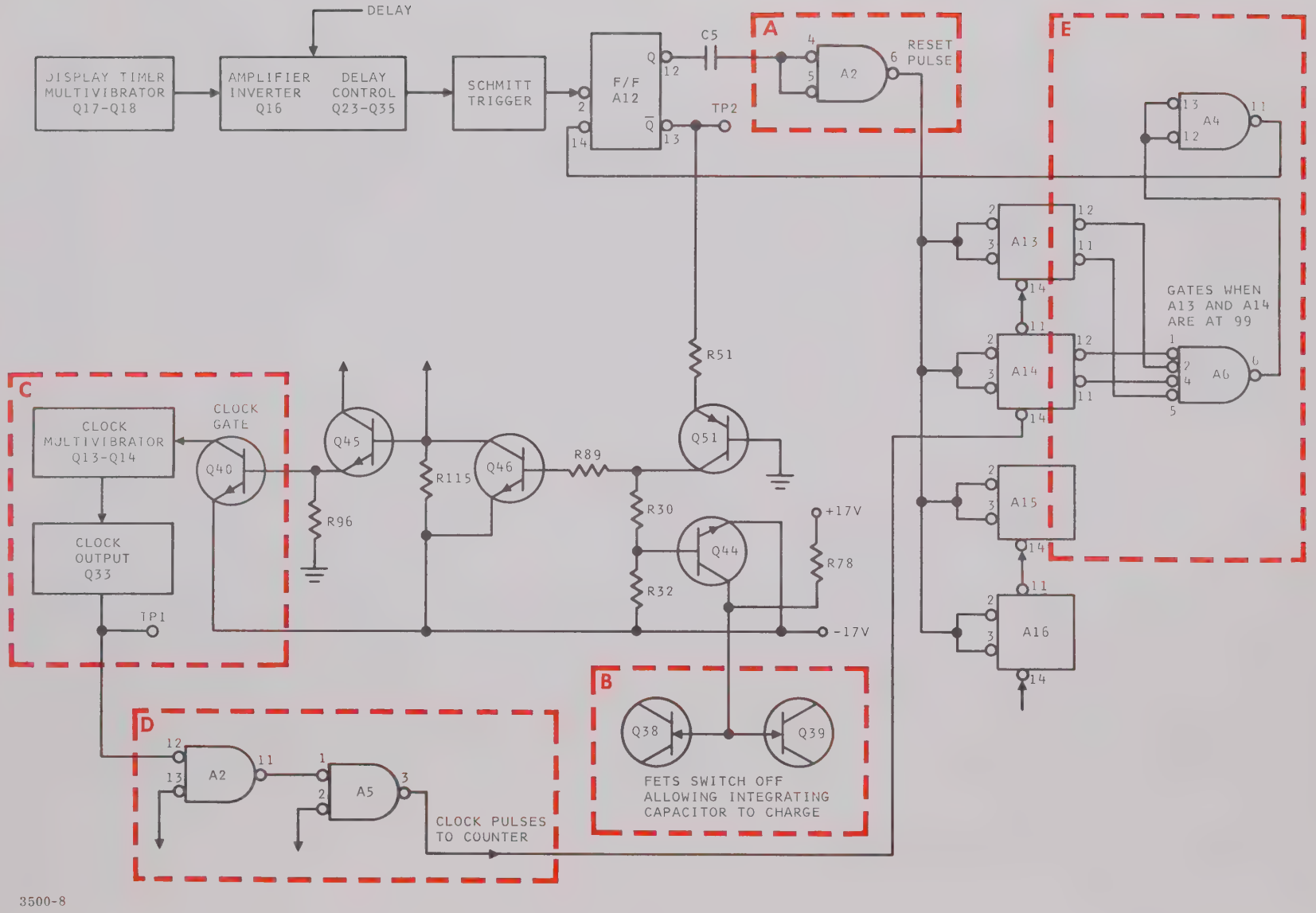


Figure 3-7. Simplified Diagram - Digitizing Circuits

The digitizing period continues with the integrating capacitors discharging while clock pulses are being counted. If the level sensing circuits detect the 175 digit level during the discharge, the "Fast" reference discharge is switched out, leaving the "Slow" discharge rate. The count proceeds until the Null Detector input, Q60, senses that the integrating capacitors have discharged to the pre-digitizing state. At this point, clock gate control Q40 is actuated by Q45 in the Null Detector circuit, stopping the clock and the count. The digitizing period ends, followed by the 4-mSec Display Timer pulse which illuminates the count in the readout and resets the digitizing circuits.

3-24. POLARITY INDICATING CIRCUIT (Figure 3-8)

3-25. Polarity is determined at the end of every integrating period. The DC level at the output of the buffer-amplifier is fed to Q61, a differential transistor pair, through R53. CR7-CR8 limit signals of either polarity. Q61 is direct coupled to Q42 which drives the Polarity Flip-Flop, formed by two sections of A1.

3-26. The Polarity Flip-Flop is reset at the end of every integrating cycle by the output of A6 through CR3 and C3, sharply pulsing pin 9 of A1.

3-27. If a positive polarity is present, the Polarity Flip-Flop remains in the rest state, driving Q9 which lights "+" indicator lamp DS3. A negative polarity will cause the collector of Q42 to go negative when gated by A6, setting the Polarity Flip-Flop after every reset pulse which lights the "-" indicator lamp DS4.

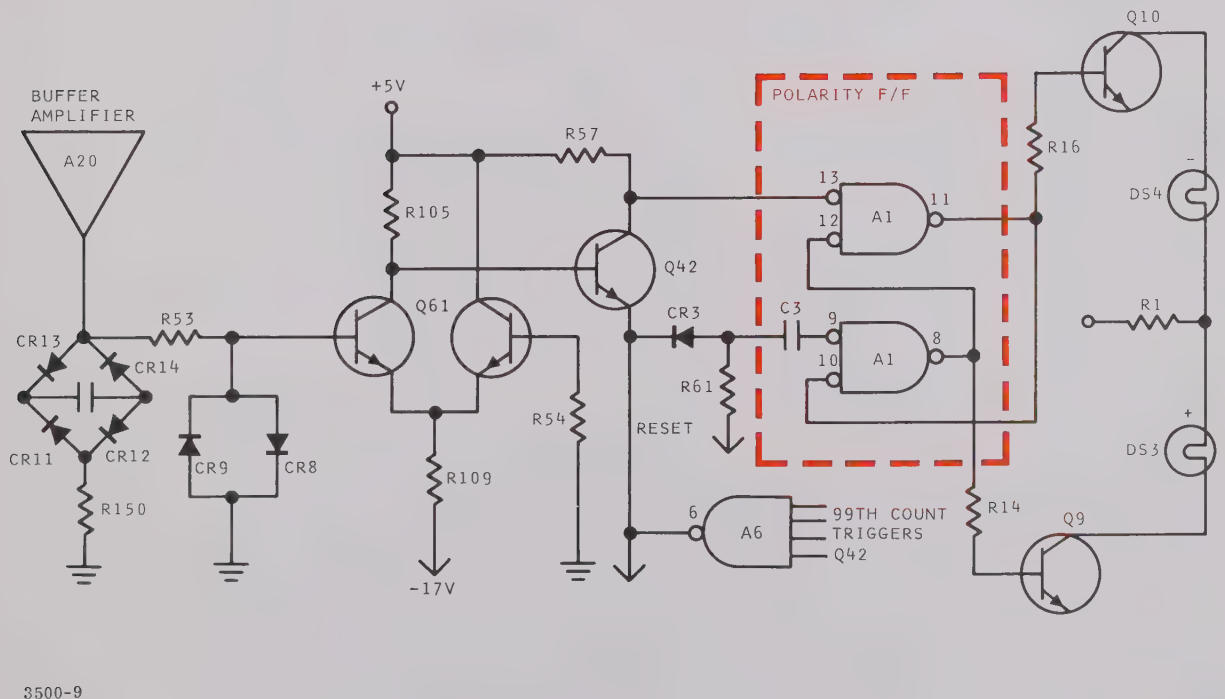


Figure 3-8. Simplified Diagram - Polarity Circuit

3-28. AUTO-RANGING CIRCUIT (Figure 3-9)

3-29. Auto-ranging is controlled by the states of two Flip-Flops, F-F 1 and F-F 2 in A11. The four auto ranges correspond to the four possible states of these two Flip-Flops. The outputs of the Flip-Flops actuate relay drivers Q25 thru Q28 which drive the range selecting relays. The Flip-Flop outputs are also decoded by four gates in A3 which feed decimal driver transistors Q5 thru Q8, illuminating the corresponding decimal light.

3-30. Up-Ranging. An up-range pulse is generated at the output of gate A17, pin 8, when the following conditions occur:

1. 12000 clock pulses are counted.

2. The over-range "1" is present.

3. The clock pulses cease (end of clock pulse detected by Q11 and Q41, gating pin 10 of A17).

An up-range pulse from pin 8 of A17 to pins 2 and 6 of Flip-Flop A11 places the instrument in its highest range.

3-31. Down-Ranging. A down-range pulse is generated at the output of gate A17, pin 6, when the following conditions occur:

1. The two most significant numbers in the readout are 00.

2. The clock pulses cease (end of clock pulses detected by Q11 and Q41, gating pin 5 of A17).

A down-range pulse at pin 16 of A17 causes the instrument to drop to the next lowest range.

3-32. DATA OUTPUT OPTION

3-33. The Data Output Option incorporates circuitry to permit external triggering of the instrument and provides a print pulse when a valid reading has been made. Data output is provided at the rear of the instrument through the output connector J9.

3-34. CIRCUIT DESCRIPTION (Figure 3-10)

3-35. The print pulse is generated when a Flip-Flop (formed by two sections of A22) is reset. An input trigger pulse sets the Flip-Flop. When the instrument determines that a reading has been made in the proper range, a reset pulse is generated, resetting the Flip-Flop which generated the print pulse. An external trigger grounding pulse is applied to pin 47 of the Data Output connector J9 causing Q101 to cut off. The collector of Q101 is tied to pin 13 of Flip-Flop A22, which sets.

3-36. The Flip-Flop will reset only when the following conditions are met:

1. A reading has been taken and clock pulses have ceased (Q41 detects end of pulses and gates A21 via pin 9.

2. Gate A21 (pins 4 and 5) has not detected an Up- or Down-range pulse from gate A17, pins 6 and 8.

3-37. The absence of both Up- and Down-range pulses plus the absence of clock pulses gates A21 via pins 9 and 10. The gate output at pin 8 is coupled through another section of A21 via pins 12 and 13, the output at lin 11 triggering the reset of Flip-Flop A22 at pin 9. When the Flip-Flop resets, the output change at pin 11 of A22 is capacitively coupled to Q100. Q100 feeds another

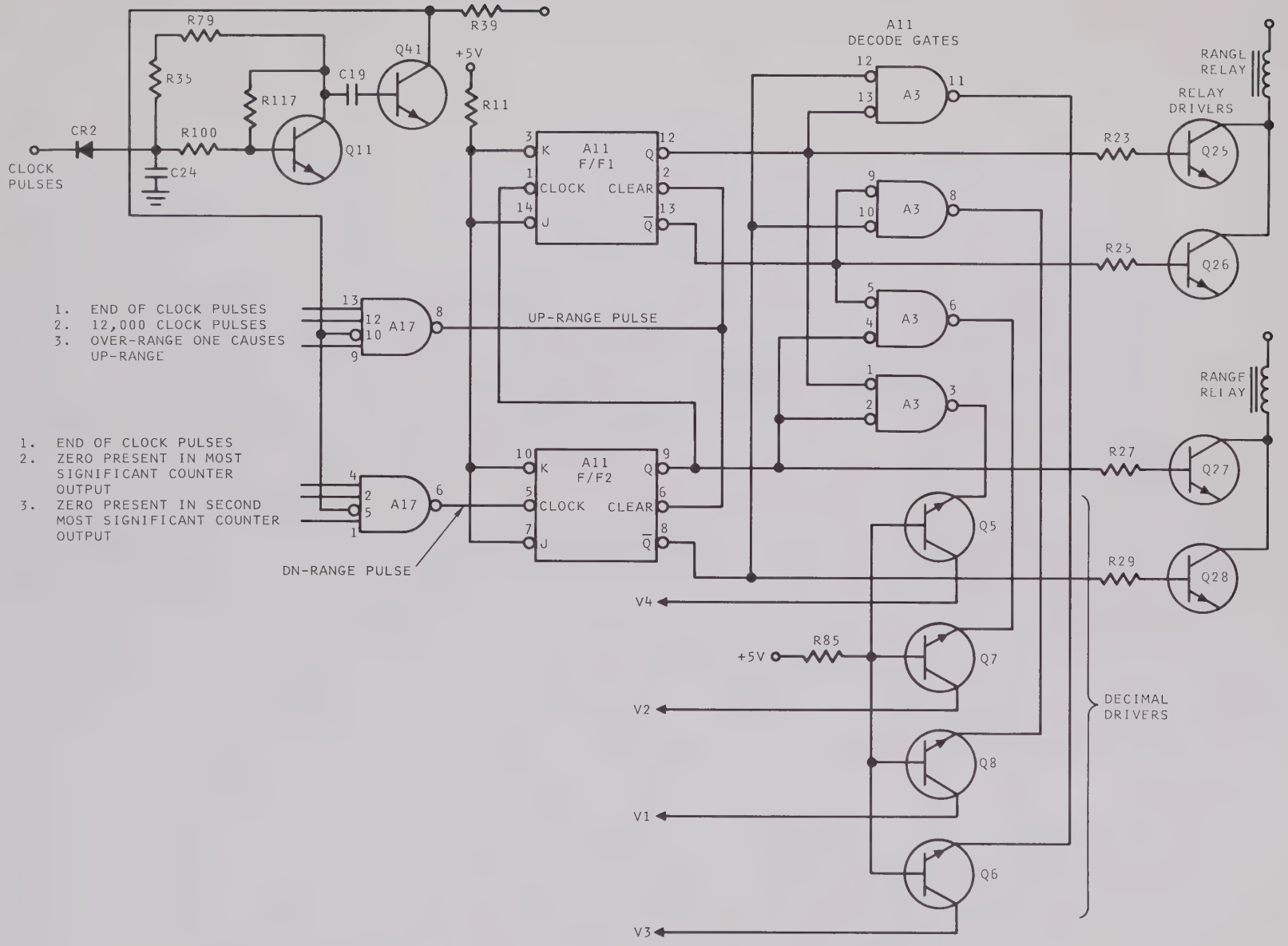


Figure 3-9. Simplified Diagram - Auto-Ranging Circuit

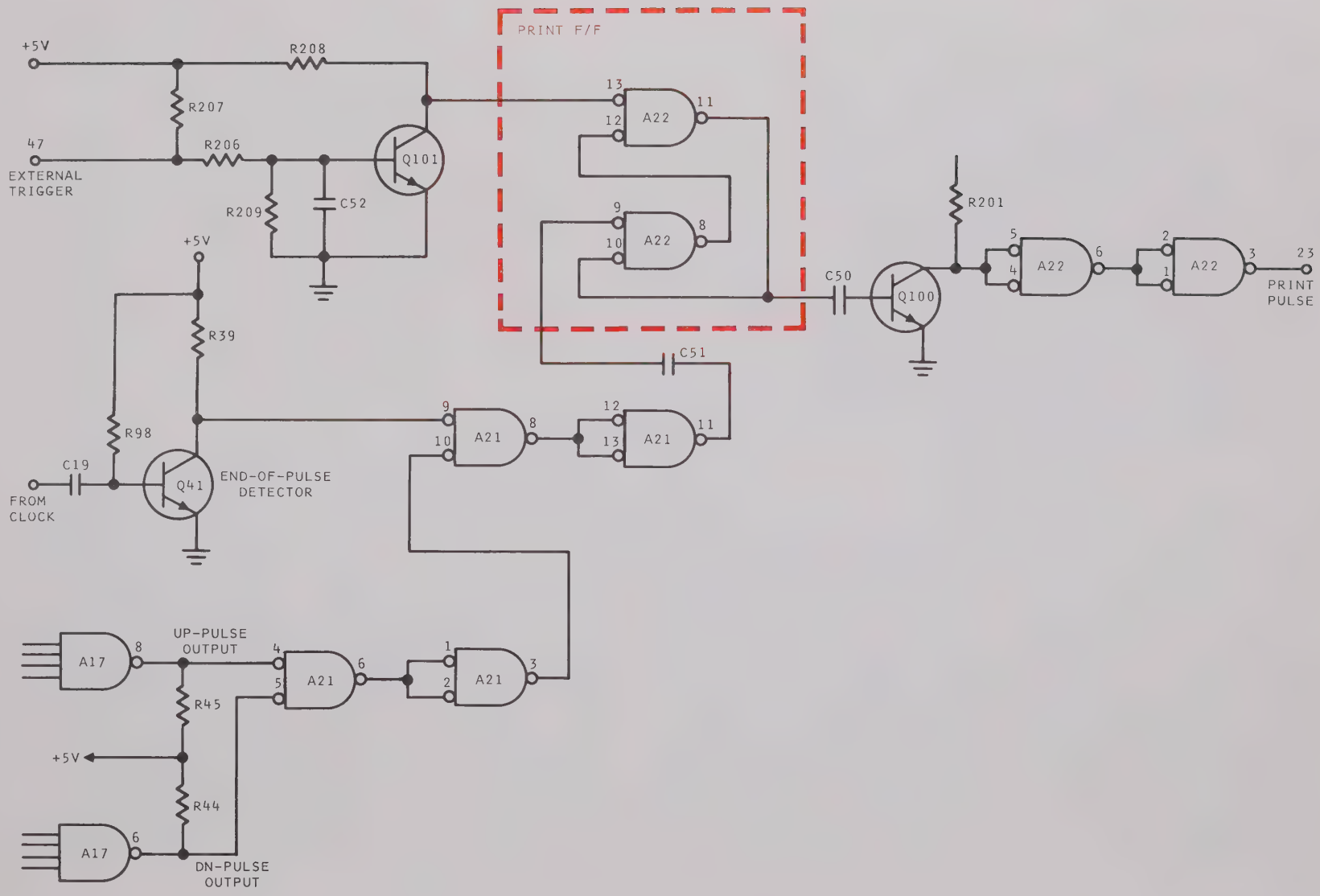


Figure 3-10. Simplified Diagram - External Trigger and Print Pulse Generator

section of A22 which feeds a second section similarly connected. Pin 3 of the second section is the output source of the print pulse at pin 33, J9.

3-38. RECHARGEABLE BATTERY OPTION

3-39. The LX-2 may be powered by the AC power line or by the optional rechargeable battery pack. The battery option uses a modified power supply which provides power for charging the battery pack and contains an inverter unit which provides ±17 volts and a 250V supply for the readout lamps.

3-40. CIRCUIT DESCRIPTION (Refer to Schematic Diagram 35-32)

3-41. Five-Volt Supply. Transformer D302 feeds full-wave rectifiers CR31-CR32. The rectified output is filtered by C40 thru C43 and is applied to the 5-volt regulator formed by Q30, Q31 and Q37. The regulated output appears at the collector of Q37 and is fed to the instrument. In the battery mode, the positive end of the battery is connected thru pin 19 of P1 which connects to J8, pin 19 and in turn to the input of the 5-volt regulator. CR31-CR32 block the DC path through the transformer.

3-42. Battery Charger Supply. Transformer D302 also supplies power for the battery charging circuits thru pins 17 and 18 of J8 which connects to pins 17 and 18 of P1. CR3-CR4 full-wave rectify the AC, applying DC to the battery thru current-limiting lamps V1 and V2. The battery pack charges automatically as long as the instrument is connected to the AC power line and the power switch is on.

3-43. When operating from the power line, Q7 actuates the battery disconnect relay (K1) which removes the battery as the 5-volt source, substituting the AC line-operated power supply discussed above. The battery disconnect circuit operates as follows: The presence of AC causes CR1 and C2 to provide a forward bias to Q7 which actuates relay K1, disconnecting the battery from the 5-volt line.

3-44. Battery Lo Lamp. Lamp DS2 (battery LO) indicates the condition of the battery pack. DS2 is actuated when differential pair Q9 and Q10 sense sufficient change in the battery output voltage as compared to the regulated 5-volt supply. The regulated five volts is applied to the base of Q10 while the battery output is sampled at the base of Q9 thru a resistive divider, R9 and R12. Unbalance in the inputs of Q9 and Q10 causes Q8 to turn on and illuminate DS2, indicating a drop in battery voltage.

3-45. Inverter. Transistors Q1 and Q2 have forward bias applied through R16. One transistor will differ from the other and so will conduct more heavily, allowing more current flow through the transistor and its primary winding. Current induced in the feedback winding cuts off the other transistor. This action continues until the transformer core saturates, causing the rate of charge of the magnetic flux to drop to zero, removing the base drive on the conducting, transistor. The current begins to decrease, reversing the magnetic flux causing base drive to appear on the other transistor, repeating the cycle in the other direction. Essentially, this action causes Q1 and Q2 to act as switches, effectively connecting the input power alternately across each half of the center-tapped primary winding, producing a 2KHz square wave power source. Secondary windings step up the battery voltage. The high voltage secondary is connected to pins 11 and 13 of P1 which connect to J8 and feed full-wave rectifier CR27 thru CR30.

After filtering by C36, 250 volts becomes available to drive the readout indicators. Another secondary winding feeds pins 15 and 16 with its center tap tied to pin 20. This additional winding provides power to CR23 and CR25, the -17-volt power supply and to CR24 and CR26, the +17-volt power supply.

CHAPTER IV

MAINTENANCE

4-1. INTRODUCTION

4-2. This chapter provides information pertaining to preventive and corrective maintenance for the Series LX-2 Digital Multifunction Meter. Preventive maintenance essentially consists of inspection of the instrument and components for damage or signs of overheating, and cleaning the instrument. This maintenance should be performed at 30-day intervals or as operating conditions permit. Corrective maintenance consists of performance tests, which are provided to assist in maintaining the instrument within its operating specifications, component replacement (tubes, lamps, etc.), calibration, and troubleshooting aids. Particular attention should be given to the Theory of Operation Chapter and the schematic diagrams in this manual prior to performing any troubleshooting, since a knowledge of the principles of operation of the instrument is of primary value in troubleshooting.

4-3. EQUIPMENT REQUIRED

4-4. The equipment recommended for performance testing, calibration and troubleshooting the instrument is listed below.

1. A DC Voltage Standard; John Fluke Model 332A, or equivalent.
2. An Ohms Standard; E.S.I. Model DB52, or equivalent.
3. An Audio Voltage Standard; Holt Model 631B, or equivalent.
4. An Oscilloscope; Tektronics Model 502, or equivalent.
5. A voltmeter; Triplett Model 630-NA, or equivalent.
6. A Variac, "Powerstat" Type 3PN, Superior Electric Co., or equivalent.
7. 1.5-Volt Flashlight Cell or 1.3-Volt Mercury Cell.

4-5. GENERAL MAINTENANCE

4-6. COMPONENT ACCESS

4-7. The following steps are provided to enable the user to disassemble the instrument in the easiest manner down to the point where further disassembly, if required, is obvious. It is not necessary to follow all of these steps to effect certain repairs or replacements. The following paragraphs of this chapter, pertaining to replacement of parts, calibration or troubleshooting, will refer to steps in this paragraph which are required to be taken prior to proceeding with replacement, calibration or troubleshooting. Reassemble in reverse order of disassembly as required.

NOTE

Although not necessary, it may prove more convenient to remove the handle while performing maintenance on the instrument. To do so, turn knobs counterclockwise until they can be removed from the chassis frame.

1. Remove top cover by removing two nylon screws at rear of instrument and lifting cover upward and back toward rear of instrument.
2. Remove top shield by removing four encircled screws. If battery option is included, a battery pack is located

on the underside of the shield with two wires connected to battery option printed circuit board located at rear of instrument.

CAUTION

Do not disconnect these two wires if instrument is operating or damage to components may result.

3. Remove Function Switching Assembly (Figure 4-1) by removing four attaching screws and disconnecting connectors P1 and P2 from Main Board Assembly.
4. To maintain circuit integrity and gain access to components located under the Function Switching Assembly, remove only the four screws and place the assembly upright in the slots provided (Figures 4-1 and 4-2).
5. If battery option is included, remove printed circuit board located at rear of instrument by removing four attaching screws and disconnecting connector P1 from Main Board Assembly.
6. Remove bottom cover by removing two nylon screws on bottom of instrument and lifting cover upward and back toward rear of instrument.
7. Remove bezel (Figure 4-3) by removing four attaching screws, lockwashers and nuts and pulling bezel away from front of instrument.
8. Remove bottom shield by removing four attaching screws.
9. Remove shield located on bottom of instrument under signal input connectors (Figure 4-4). by removing two

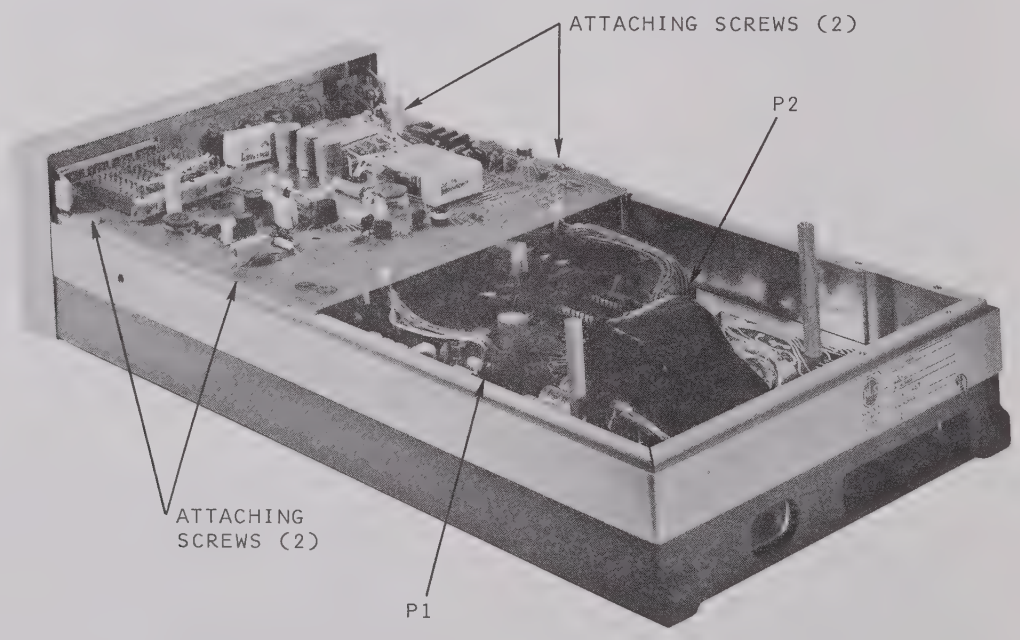


Figure 4-1. Function Switching Assembly Removal

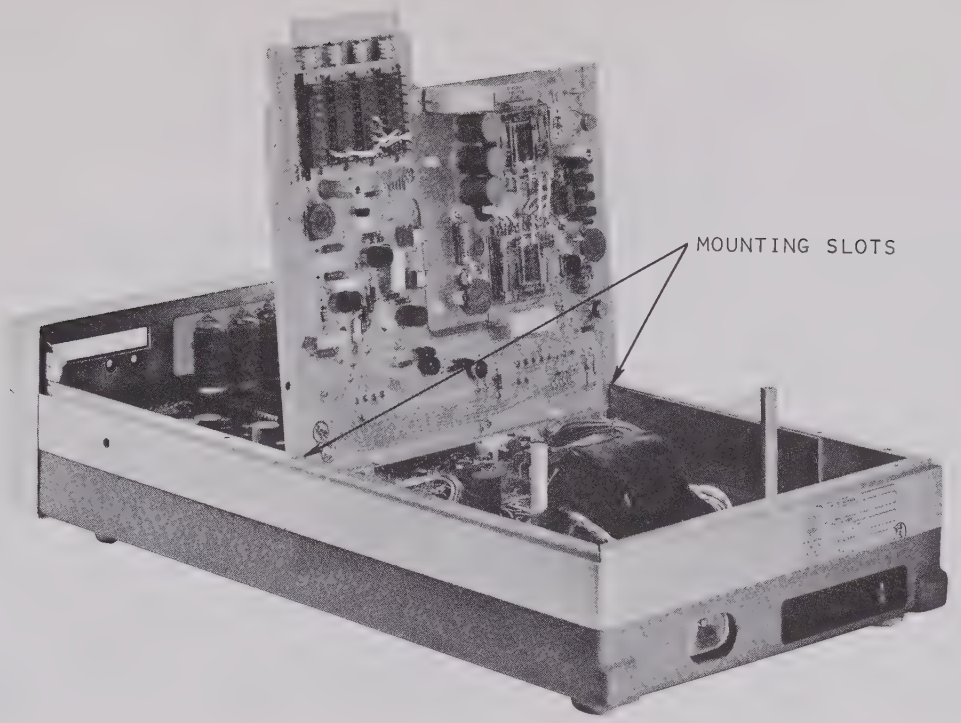


Figure 4-2. Partial Disassembly for Circuit Testing

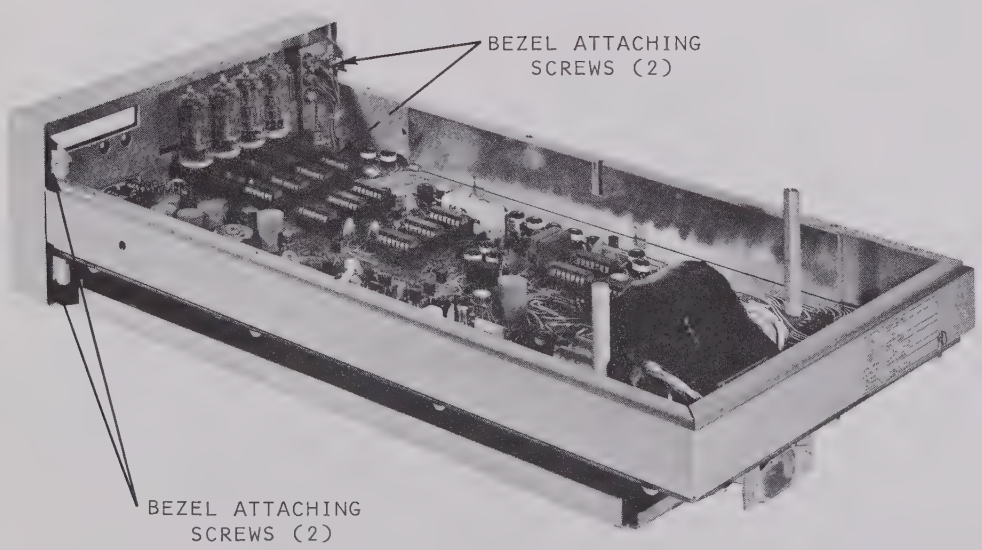


Figure 4-3. Bezel Removal

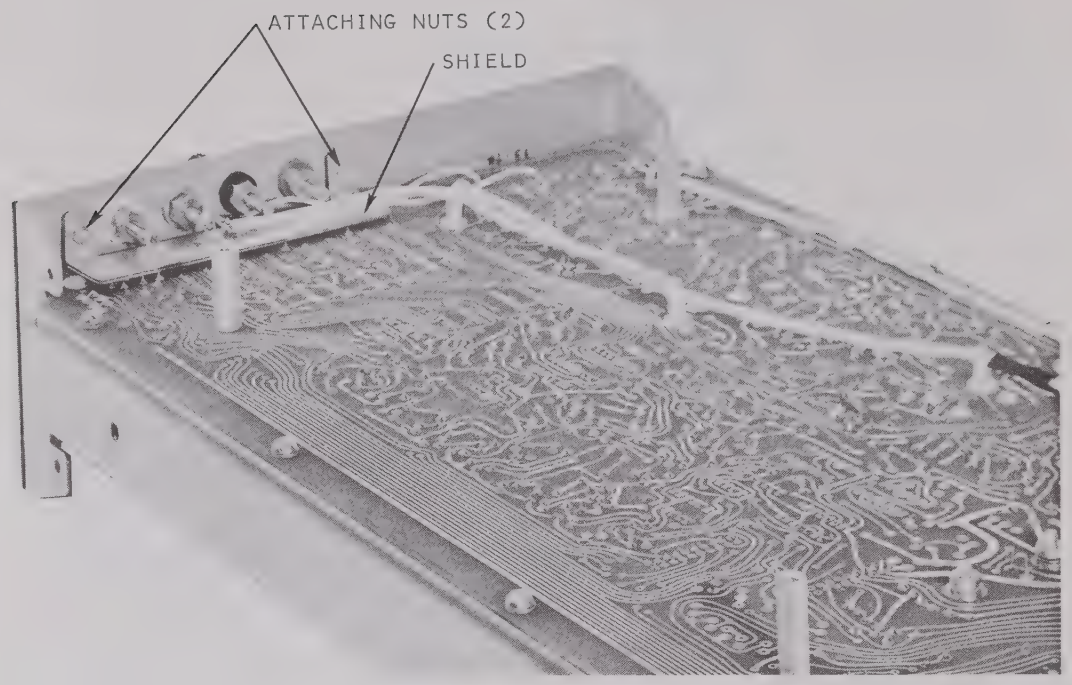


Figure 4-4. Readout Shield Removal

attaching nuts and lockwashers.

10. Remove polarity and battery low lamp bulb bracket from front plate by removing screw on side of instrument (Figure 4-5) and removing screw on bottom of instrument (Figure 4-6).

4-8. INSPECTION AND CLEANING

4-9. Perform steps 1, 2, 3, 5, 6 and 8 as set forth in paragraph 4-7. Inspect chassis, printed circuit boards and all mounted components for damage, signs of overheating, etc. Check front panel pushbutton switches for ease of operation.

4-10. Remove any accumulated dust with low-pressure, clean, dry air. Clean front panel and exterior surface with a soft cloth dampened with a mild solution of detergent and lukewarm water.

4-11. FUSE REPLACEMENT

4-12. Two fuses are located inside the instrument; if the battery option is included, a third fuse is provided. To gain access to fuses, perform steps 1 and 2 as set forth in paragraph 4-7. The line fuse (F1) is located on Main Board Assembly and is rated at one-half ampere (one-fourth ampere if instrument has been converted to 230-volt operation). The ohms circuit-protection fuse (F2) is located on Function Switching Assembly and is rated at one one-hundredth ampere. The battery line fuse (F3) is located on Battery Option printed circuit board and is rated at three amperes.

4-13. INTEGRATED CIRCUIT REPLACEMENT

4-14. The integrated circuit packages (A1 thru A17-also A21 and A22 if print option is

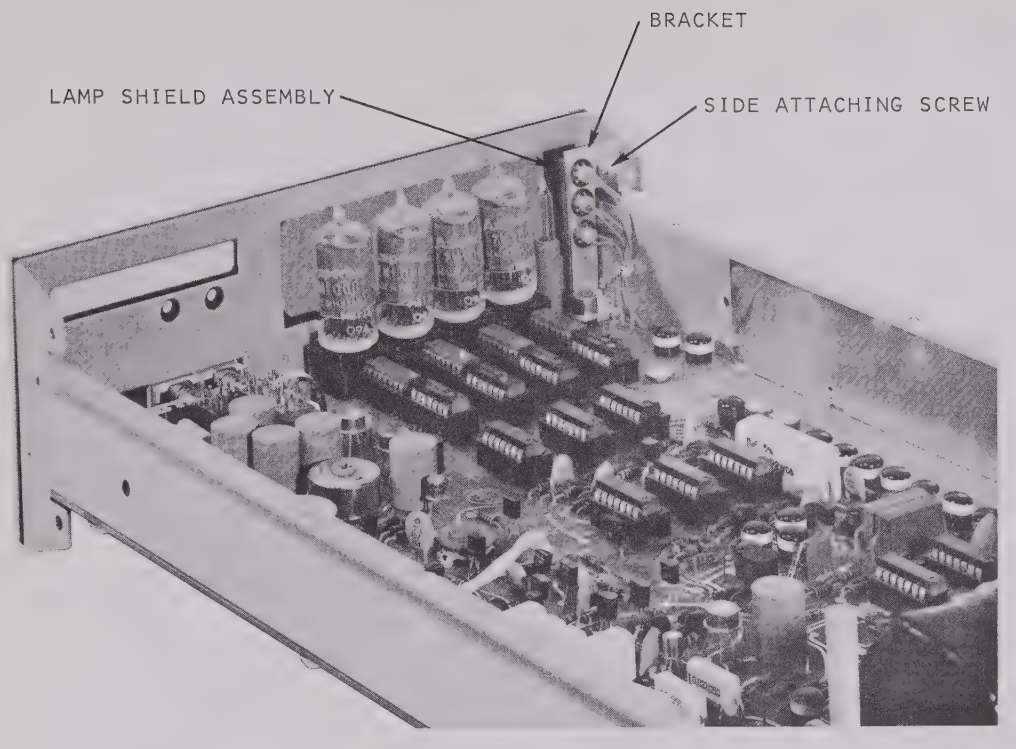


Figure 4-5. Lamp Bulb Bracket Removal

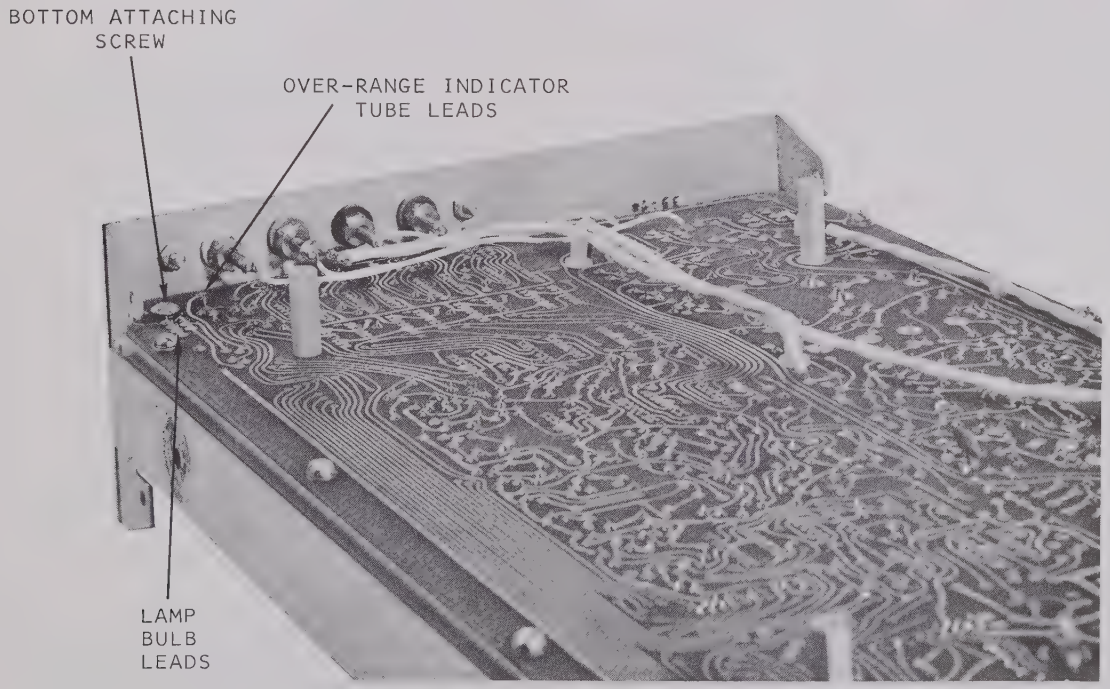


Figure 4-6. Lamp Bulb Bracket Removal and Component Leads

included) on the Main Board Assembly are mounted in sockets for ease of replacement. To replace any of these components, perform steps 1 thru 3 as set forth in paragraph 4-7. These components are properly installed when the keyed notch faces the rear of instrument except the readout drivers which are located directly behind the readout tubes - these must face the front.

4-15. READOUT TUBE REPLACEMENT

4-16. Access to the decimal, 0 thru 9-readout tubes may be gained by performing steps 1, 2, 3, 6 and 7 as set forth in paragraph 4-7. With a rocking motion, carefully pull faulty tube from its socket. Install new tube, using care to properly align pins into tube socket.

4-17. OVER-RANGE INDICATOR TUBE REPLACEMENT

4-18. The numeral "1" over-range indicator tube (DS1) leads are soldered to printed circuitry on the bottom of Main Board Assembly. Replace this tube as follows:

1. Perform steps 1 thru 3 and 6 thru 9 as as set forth in paragraph 4-7.
2. Unsolder tube leads at points indicated in Figure 4-6.
3. Solder leads of new tube into place, taking care to ensure a firm and clean solder connection.

4-19. POLARITY AND BATTERY LOW LAMP REPLACEMENT

4-20. The "+", "-" and BAT LO indicator lamps DS2, DS3 and DS4) leads are soldered to printed circuitry on the bottom of Main Board Assembly. Replace these lamps as follows:

1. Perform steps 1 thru 3 and 6 thru 10 as set forth in paragraph 4-7.
2. Pull lamp bulb bracket away from front plate and remove lamp shield assembly (Figure 4-5). Note that the shield assembly is installed so that the largest of the three recesses is placed at the bottom.
3. Remove retaining ring holding faulty bulb to bracket.
4. Remove faulty bulb from opening in bracket.
5. Unsolder leads of faulty bulb at point indicated in Figure 4-6.
6. Solder leads of new bulb into place, taking care to ensure a firm and clean solder connection.

4-21. BATTERY REPLACEMENT

4-22. If the battery option is installed, replace batteries as follows:

1. Perform steps 1 and 2 as set forth in paragraph 4-7.
2. Remove battery leads from pin plugs on Battery Option printed circuit board. Note that the black lead is connected to the pin nearest the fuse.
3. Remove six screws attaching the battery pack to the top shield.
4. Remove and replace batteries.

4-23. BALLAST LAMP REPLACEMENT

4-24. If battery option is installed, two ballast lamps are mounted on the Battery Option printed circuit board. Replace lamps as follows:

1. Perform steps 1, 2 and 5 as set forth in paragraph 4-7 and also perform step 2 as set forth in paragraph 4-22.

2. Unsolder lamp/s from bottom of printed circuit board.

3. Solder new lamp/s into place, taking care to ensure a firm and clean solder connection.

4-25. 115/230-VOLT CONVERSION

4-26. The instrument is normally shipped from the factory for operation from 115-volt, 50-400 Hz, single phase power sources. If shipped for other operation, the serial number tag at the rear of the instrument will indicate the correct power source. Conversion of the instrument from 115-volt operation to 230-volt operation may be accomplished as follows:

1. Perform steps 1, 2, 6 and 8 as set forth in paragraph 4-7.

2. Unsolder black and red/white transformer leads from bottom of Main Board Assembly.

3. Solder leads into unused overlapping pads adjacent to other transformer lead pads. Take care to ensure a firm and clean solder connection.

4. Replace one-half ampere fuse (F1) on Main Board Assembly with a one-fourth ampere fuse.

4-27. PERFORMANCE TESTS

4-28. The following performance tests are provided to verify that the performance of the instrument meets the specifications for accuracy set forth in Chapter I. The tests may be used as a receiving inspection procedure, for routine preventive maintenance and following overhaul, repair or calibration. The tests should be conducted under the following environmental conditions: ambient temperature 20° to 30°C and relative humidity of less than 70%. If the instrument cannot meet any of the performance tests, calibration or maintenance will be required.

4-29. INITIAL PREPARATION

1. Connect the instrument to the VAC power source.

2. Ensure that the shorting strap is between the LO terminal and GUARD terminal.

3. Switch instrument on by depressing POWER pushbutton. Allow a period of 30 minutes for instrument warm-up.

4. Press the FILTER pushbutton.

NOTE

Resistance of each lead should be less then 0.1Ω to avoid measurement error.

4-30. DC VOLTAGE TEST

1. Insert input leads into HI (red) and LO (black) connectors on front panel of instrument.

2. Press VDC pushbutton switch. If the EXT. REF. switch is in the "in" position, press it to bring it out to the non-operating position.

3. Connect leads together and adjust VDC zero potentiometer (located directly under VDC switch) until readout transfers from -0000 to +0001. Back off adjustment until readout transfers from +0000 to -0001. Now place the adjustment halfway between these settings to obtain a solid +0000.

4. Connect leads of instrument to voltage standard as shown in Figure 4-7.

5. Apply voltages shown in Table I; read-

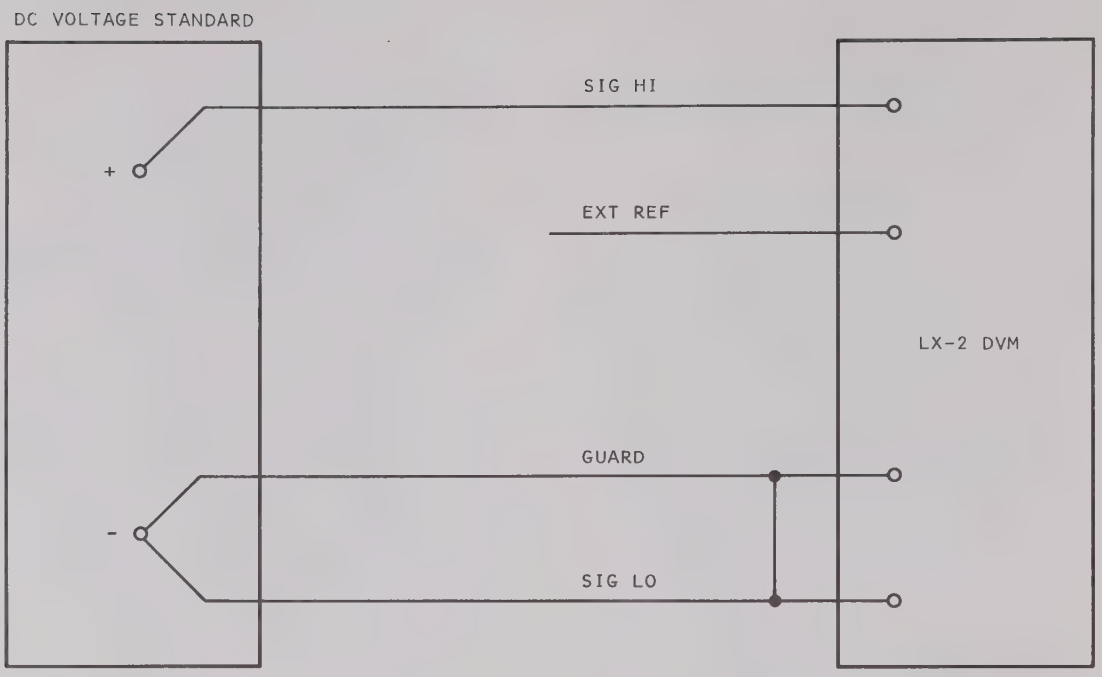


Figure 4-7. Connections for DC Voltage Measurement Test and Calibration

out should be within indicated limits.

Table I. DC Voltage Test

VOLTAGE INPUT	RANGE	READOUT LIMITS
+1.1950	1	+1.1947 to +1.1953
+11.950	10	+11.947 to +11.953
+119.50	100	+119.47 to +119.53
+ 950.0	1000	+ 949.7 to + 950.3

4-31. EXTERNAL REFERENCE TEST

1. Connect input leads of instrument to voltage standard as shown in Figure 4-8.
2. Press EXT. REF. pushbutton switch.
3. Apply voltage shown in Table II; readout should be within indicated limits.

Table II. External Reference Test

REF. INPUT	VOLTAGE INPUT	READOUT LIMITS
+10.000	+10.000	+ 9.997 to +10.003

4-32. RESISTANCE TEST

1. Connect input leads of instrument to ohms standard as shown in Figure 4-9.
2. Press KΩ pushbutton switch.
3. Apply ohmic values shown in Table III; readout should be within indicated limits.
4. Press 10^4KΩ (10 MΩ) pushbutton.
5. Apply ohmic values shown in Table IV; readout should be within indicated limits.

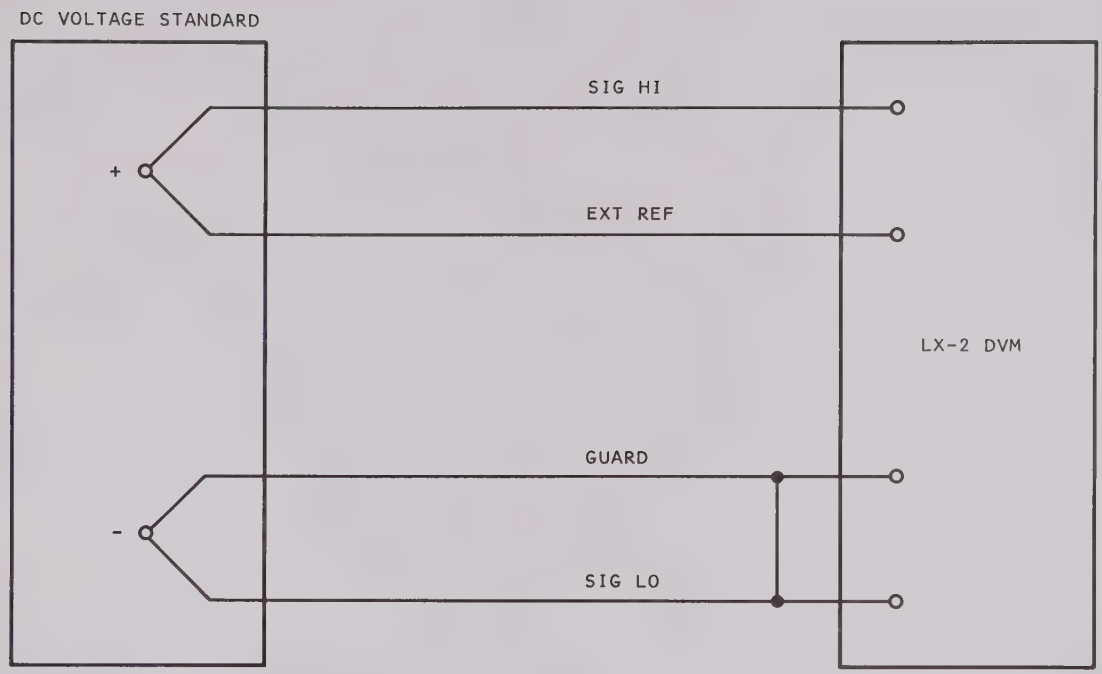


Figure 4-8. Connections for External Reference Measurement Test and Calibration

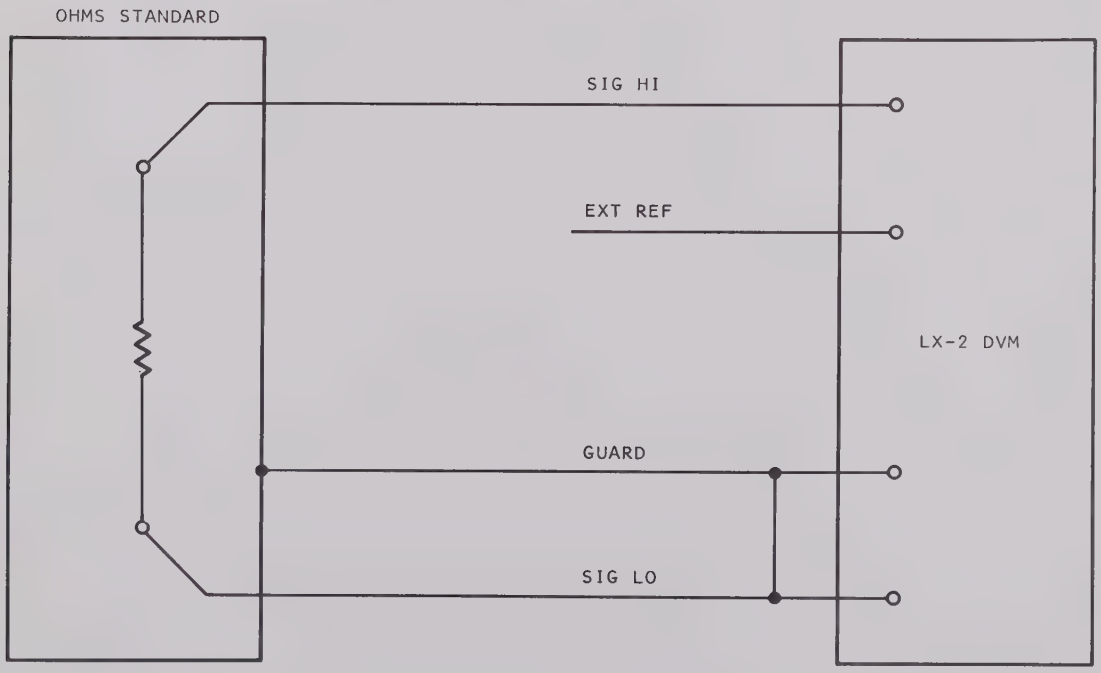


Figure 4-9. Connections for Resistance Measurement Test and Calibration

Table III. Resistance Test (KΩ)

RESISTANCE INPUT	RANGE	READOUT LIMITS
1.1950 KΩ	1	1.1947 to 1.1953
11.950 KΩ	10	11.947 to 11.953
119.59 KΩ	100	119.47 to 119.53
1201.0 KΩ	1000	1200.7 to 1201.3

Table IV. Resistance Test (10^4KΩ)

RESISTANCE INPUT	RANGE	READOUT LIMITS
12010 KΩ	10^4KΩ (10MΩ)	12003 to 12017

4-33. AC VOLTAGE TEST

1. Press VAC pushbutton switch.
2. Connect signal Hi and signal Lo leads together and adjust VAC zero potentiometer (located directly under VAC switch) until readout transfers from 0000 to 0001. Back off adjustment until readout transfers from 0001 to 0000 and then to 0001. Now place the adjustment halfway between these settings to obtain a solid 0000.
3. Connect input leads of instrument to audio voltage standard as shown in Figure 4-10.
4. Apply voltages and frequency as shown in Table V; readout should be within indicated limits.

4-34. COMMON-MODE-REJECTION TEST

1. Press the VDC pushbutton switch.
2. Connect input leads of instrument to signal source (1.5-volt flashlight cell or 1.3-volt mercury cell) and common-mode source (a variac) as shown in Figure 4-11.
3. Set variac to zero volts then advance in voltage until a two-digit "bobble" is observed in the least significant decade. (A two-digit "bobble" occurs when the display "bobbles" between the true reading, the true reading plus one digit, and the true reading minus one digit. This corresponds to a superimposed noise of two digits peak-to-peak.) Now back off the variac until the two-digit "bobble" just stops leaving a one-digit "bobble". Measure the variac output with a volt meter and convert to peak-to peak voltage.
4. To obtain rejection ratio, divide the peak-to-peak common voltage by 200mv.

$$\text{Common-mode-rejection ratio} = \frac{E_{p\text{-}p}}{2 \times 10^{-4}}$$

$$DB = \frac{E_{p\text{-}p}}{2 \times 10^{-4}}$$

$$DB = 20 \log 5{,}000\ E_{p\text{-}p}$$

5. For example, if the common-mode voltage is 7V RMS

$$E_{p\text{-}p} = 7 \times 2.828$$

$$E_{p\text{-}p} = 20V \ \& \ DB = 20 \log 5{,}000 \times 20$$

$$DB = 2 - \log 10^5$$

$$DB = 20 \times 5 = 100$$

Common-Mode-Rejection = 100 DB

4-35. CALIBRATION

4-36. In these calibration instructions, it is assumed that the instrument is in good working order and only requires calibration. If any components are defective, it may be dif-

Table V. AC Voltage Test

VOLTAGE INPUT @ 10K Hz	RANGE	READOUT LIMITS
1.1950	1	1.1933 to 1.1967
11.950	10	11.933 to 11.967
119.50	100	119.33 to 119.67
950.0	1000	948.5 to 951.5

ficult, if not impossible, to calibrate the instrument.

4-37. INITIAL PREPARATION

1. Perform step 1 as set forth in paragraph 4-7.
2. Plug power cord into a 115 VAC (or 230 VAC if so wired) 50-400 Hz single phase power source, if desired; or utilize internal battery power source, if this option is included.
3. Press the pushbutton POWER switch and allow 30 minutes for instrument warm-up.

NOTE

It will be noted that access holes for adjustment points are provided and that they are labeled as to function and by sequence number (Figure 4-12. The STEPS in these calibration procedures correspond to the numbered STEPS adjacent to each access hole.

4-38. PROCEDURE

4-39. VDC Zero Adjustment

1. Insert input leads into the HI (red) and LO (black) connectors on the front panel of the instrument. Ensure that the shorting strap is connected

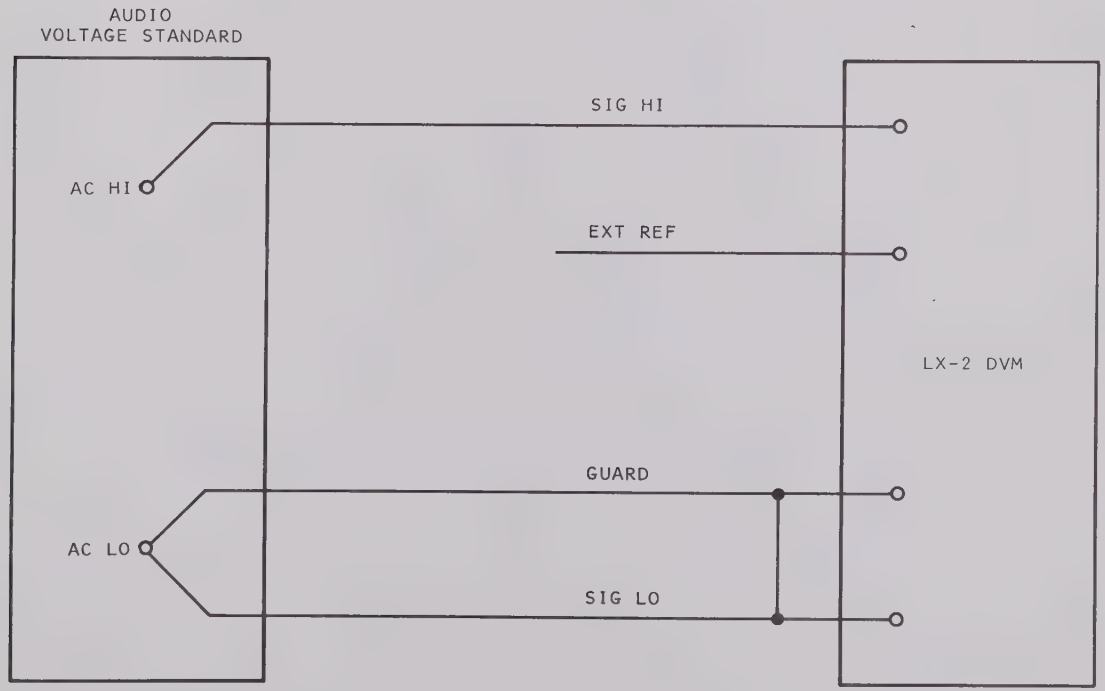


Figure 4-10. Connections for AC Voltage Measurement Test and Calibration

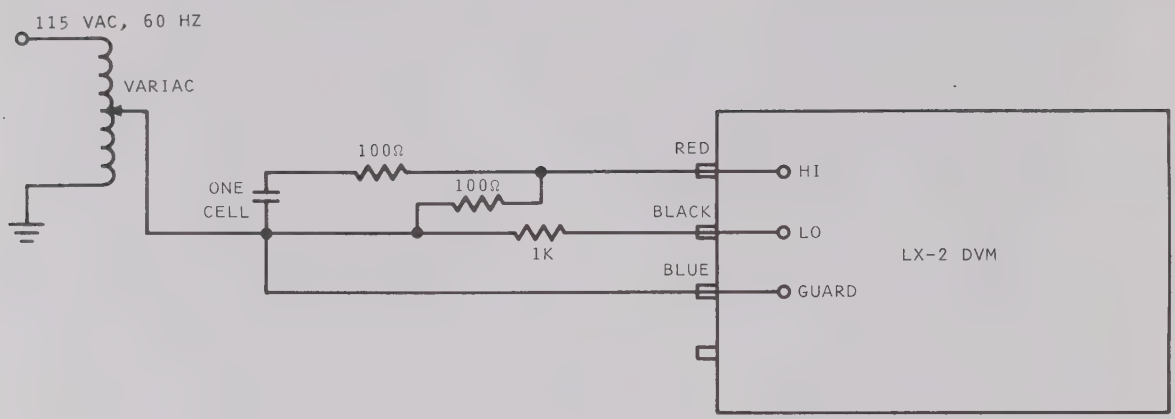


Figure 4-11. Connections for Common-Mode-Rejection Test

between the LO and GUARD connectors. Press the VDC and FILTER pushbutton switches. If the EXT. REF. switch is in the "in" position, press it to bring it out to the non-operating position.

2. Connect the leads together and adjust VDC Zero potentiometer, R6 - STEP NO. 1 - until the readout transfers from -0000 to +0001. Back off the adjustment until the readout transfers from +0000 to -0001. Now place the adjustment halfway between these settings to obtain a solid 0000.

4-40. Fast Detector Adjustment

1. Note the location of the Fast Detector potentiometer, R10 - STEP NO. 2.

2. Perform step 2 as set forth in paragraph 4-7 to gain access to Test Points 1 and 2. They are labeled TP1- and 2 and are located near the center of the Main Board Assembly at the rear of the Function Switching Assembly.

3. Using an oscilloscope, set sweep speed at 2 ms/cm and externally synchronize on the leading edge of pulse at TP2. Set vertical sensitivity to 2V/cm and display clock pulses at TP1. Apply +0. 0195 VDC to input of instrument (Figure 4-7). Rotate Fast Detector potentiometer, R10 - STEP NO. 2 - fully counterclockwise. A train of clock pulses should appear on the screen for 12. 5 ms. Rotate Fast Detector potentiometer clockwise until clock pulses just transfer to 8 ms duration. Verify the setting of the potentiometer by determining at what input voltage the clock pulses transfer from 12. 5 ms duration to 8 ms

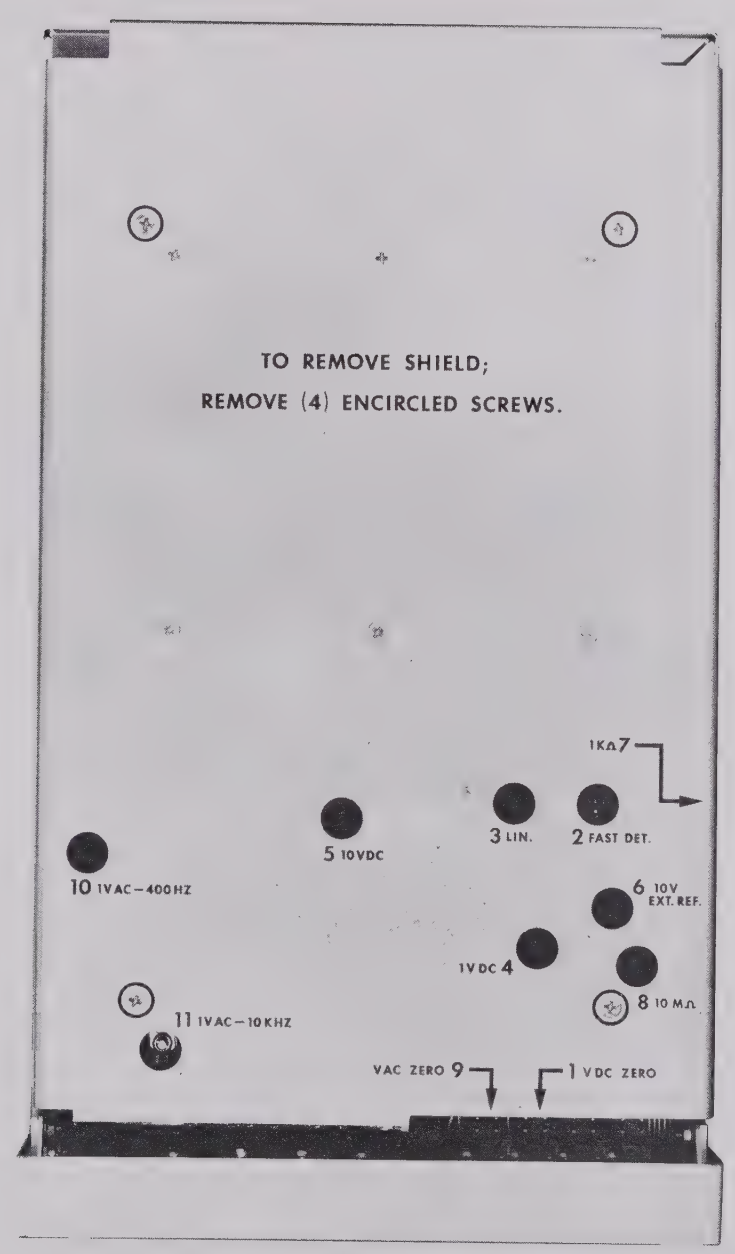


Figure 4-12. Location of Adjustment Points

duration. The setting is correct if this input lies within +0.0190 VDC and +0.0200 VDC.

4. Replace the shield.

4-41. Linearity Adjustment

1. Determine at what voltage the readout transfers from +.0184 VDC to +.0185 VDC (approximately +0.01846 VDC). Increase the input by +0.00200 VDC and adjust the Linearity potentiometer, R9 - STEP NO. 3 - until the readout transfers from +.0204 VDC to +.0205 VDC.

4-42. 1-VDC Range Adjustment

1. Connect the input leads of the instrument to the DC voltage standard as shown in Figure 4-7.
2. Apply +1.1950 volts and adjust potentiometer R8 - STEP NO. 4 - until the readout displays +1.1950.

4-43. 10-VDC Range Adjustment

1. Apply 11.950 volts and adjust potentiometer R3 - STEP NO. 5 - until the readout displays 11.950.
2. No adjustments are required for the upper two DC ranges, however they should be checked to ensure compliance with the specifications; i.e., apply 119.50 VDC and 950 VDC and check accuracy (should be within ±3 digits).

4-44. External Reference Adjustment

1. Connect the input leads of the instrument to the DC voltage standard as shown in Figure 4-8.
2. Press the EXT. REF. pushbutton switch.
3. Apply +10.000 volts and adjust potentiometer R7 - STEP NO. 6 - until the readout displays 10.000.
4. Press the EXT. REF. pushbutton switch to return it to the non-operating position.

4-45. 1-KΩ Range Adjustment

1. Press the KΩ pushbutton switch.
2. Connect the input leads of the instrument to the ohms standard as shown in Figure 4-9.
3. Apply 1.1950 KΩ and adjust potentiometer R4 - STEP NO. 7 - until the readout displays 1.1950.
4. No adjustments are required for the upper three KΩ ranges, however they should be checked to ensure compliance with specifications; i.e., apply 11.950 KΩ, 119.50 KΩ and 1195.0 KΩ and check accuracy (should be within ±3 digits).

4-46. 10^4-KΩ Range Adjustment

1. Press the 10-MΩ (10^4-KΩ) pushbutton switch.
2. Apply 11950 KΩ and adjust potentiometer R2 - STEP NO. 8 - until the readout displays 11950.

4-47. VAC Zero Adjustment

1. Press the VAC pushbutton switch.
2. Connect the signal HI (red) and signal LO (black) input leads together and adjust VAC Zero potentiometer, R5 - STEP NO. 9 - until the readout trans-

fers from 0000 to 0001. Back off the adjustment until the readout transfers from 0001 to 0000 and then to 0001. Now place the adjustment halfway between these settings to obtain a solid 0000.

4-48. 1-VAC/400-Hz Range Adjustment

1. Connect the input leads of the instrument to the audio voltage standard as shown in Figure 4-10.
2. Apply 1.1950 VAC, 400 Hz and adjust potentiometer R1 - STEP NO. 10 - until the readout displays 1.1950.

4-49. 1-VAC/10K Hz Range Adjustment

1. Apply 1.1950 VAC, 10K Hz and adjust capacitor C1 - STEP NO. 11 - until the readout displays 1.1950,
2. No adjustments are required for the upper three VAC ranges, however they should be checked to ensure compliance with specifications; i.e., apply 11.950 VAC, 119.50 VAC and 950 VAC and check accuracy (should be within ±17 digits).

4-50. TROUBLESHOOTING

4-51. The following information is provided to assist in troubleshooting the instrument. Prior to checking internal voltages and observing waveforms to aid in isolation of the trouble, it should be definitely determined that the problem is actually in the instrument, not faulty AC line voltage or connection, faulty input connection or improper control settings. If these items are verified to be satisfactory and if the instrument fails to meet the performance tests and in addition cannot be calibrated, proceed with internal checking.

4-52. POWER SUPPLIES

4-53. In the following tests, the power supplies are checked with the voltmeter described in paragraph 4-4.

1. Perform steps 1, 2, and 4 as set forth in paragraph 4-7.
2. Connect instrument to AC line and press POWER pushbutton switch. Allow a period of 30 minutes for instrument warm-up.
3. Connect the voltmeter between GND (Figure 4-13) and circuit test locations on Main Board Assembly as set forth in Table VI. Voltmeter should read as indicated.

4-54. WAVEFORMS

4-55. In the following tests, waveform pattern are checked with the oscilloscope described in paragraph 4-4. Table VII provides test point locations, oscilloscope settings and reference to a figure which displays the proper pattern.

1. Perform steps 1, 2, and 4 as set forth in paragraph 4-7.
2. Connect instrument to AC line and press POWER pushbutton switch. Allow a period of 30 minutes for instrument warm-up.
3. Press VDC and FILTER pushbutton switches. Ensure that the EXT. REF pushbutton switch is in the "out" position.
4. Synchronize oscilloscope on the leading edge of pulse at TP2 (Index 9, Figure 4-13).
5. Connect instrument to voltage source

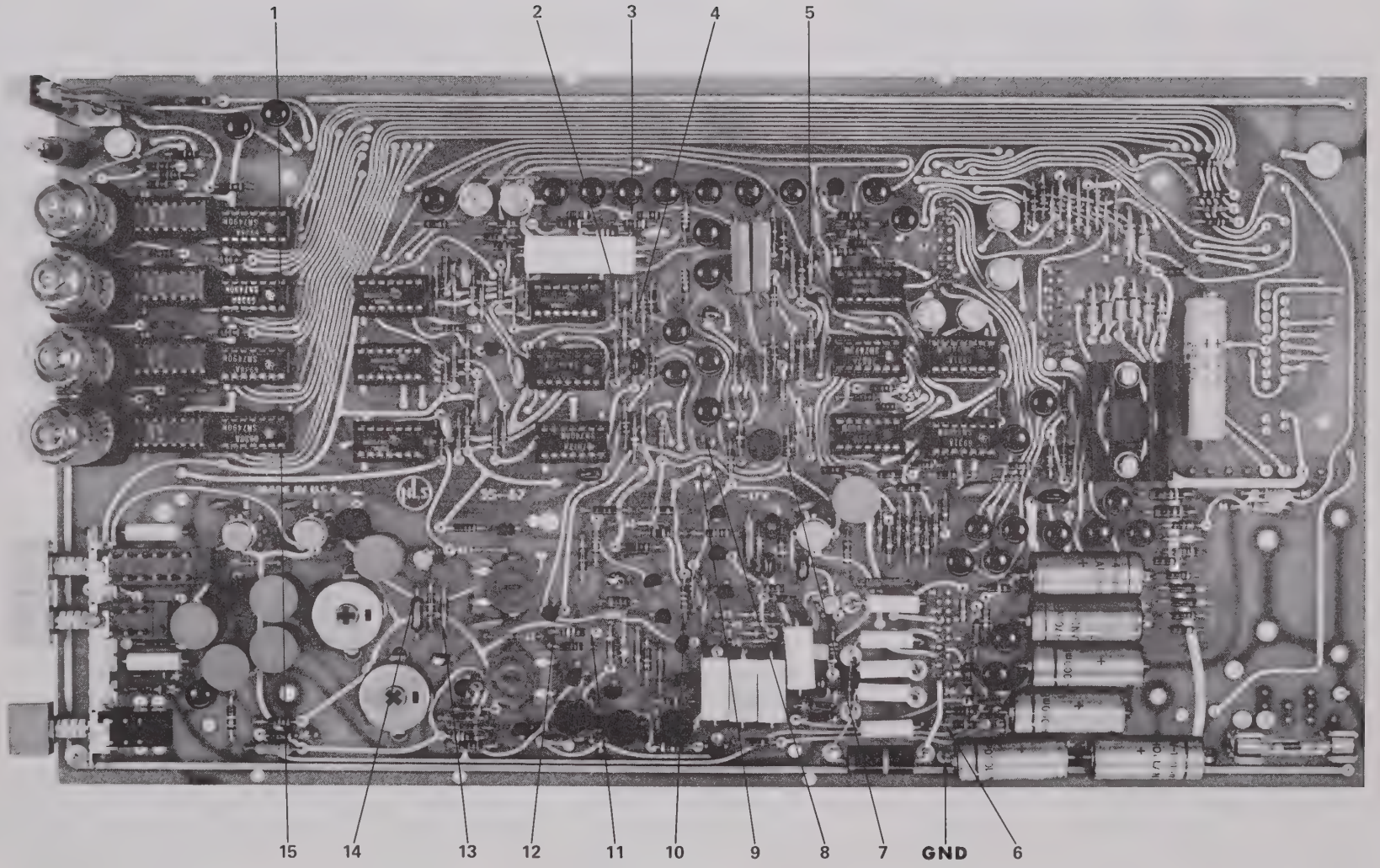


Figure 13. Main Board Assembly Circuit Test Locations

as shown in Figure 4-7 and apply 1.0278 volts.

6. Connect leads of oscilloscope to each of the test locations shown in Table VII and instrument GND (Figure 4-13). Compare waveform pattern displayed with the appropriate Figure indicated in the Table.

Table VI. Power Supply Voltage Tests

VOLTAGE TEST LOCATION		VOLTS DC	
		NOMINAL	LIMITS
Figure	Index		
4-13	2	+5	+4.6 to +5.4
4-13	11	+17	+15.5 to +18.5
4-13	6	-17	-15.5 to -18.5

Table VII. Waveform Check with Test Locations and Oscilloscope Settings

TEST LOCATION		OSCILLOSCOPE		PROPER PATTERN SHOWN IN FIGURE
		VERTICAL SENSITIVITY	SWEEP SPEED	
Figure No.	Index			
4-13	1	2V/cm	2ms/cm	4-14
4-13	3	2V/cm	10ms/cm	4-15
4-13	4	1V/cm	0.1ms/cm	4-16
4-13	5	2V/cm	2ms/cm	4-17
4-13	7	2V/cm	2ms/cm	4-18
4-13	8	2V/cm	2ms/cm	4-19
4-13	9	2V/cm	1ms/cm	4-20
4-13	10	2V/cm	2ms/cm	4-21
4-13	12	1V/cm	2ms/cm	4-22
4-13	13	5V/cm	2ms/cm	4-23
4-13	14	2V/cm	2ms/cm	4-24
4-13	15	2V/cm	2ms/cm	4-25
4-26 (Battery Option)	16	5V/cm	0.1ms/cm	4-27

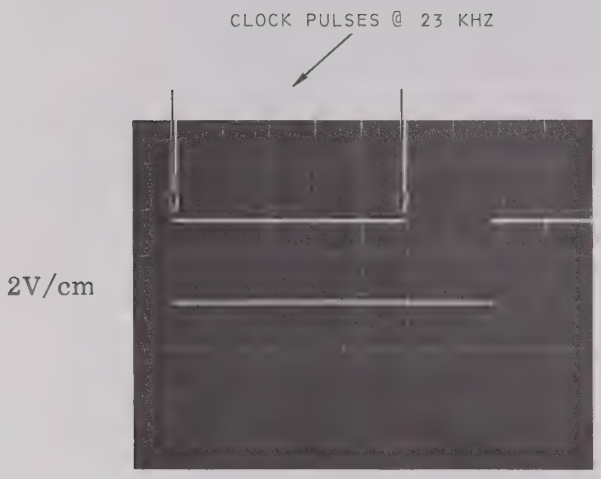


Figure 4-14. Waveform Pattern - Terminal 14 of A14 and GND

Figure 4-15. Waveform Pattern - Junction of R77 & Emitter of Q19, and GND

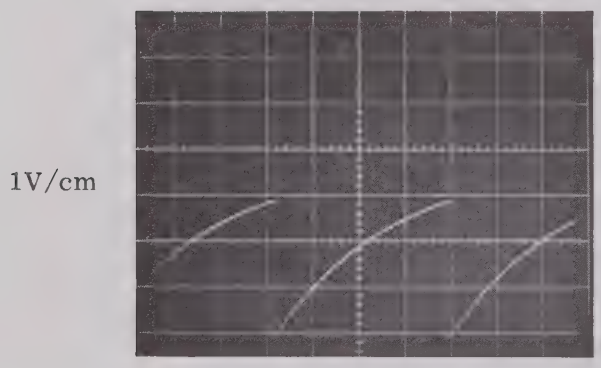


Figure 4-16. Waveform Pattern - Junction of R95 & R104, and GND

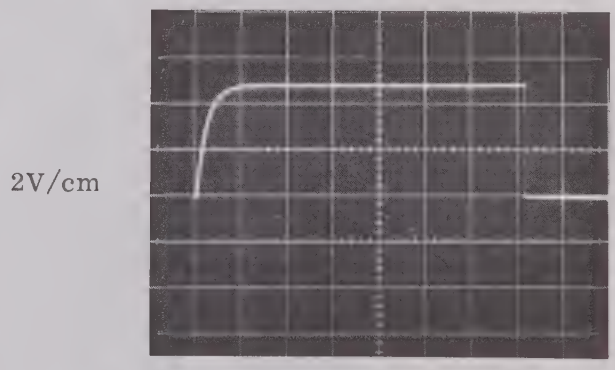


Figure 4-17. Waveform Pattern - Junction of R79 & C19, and GND

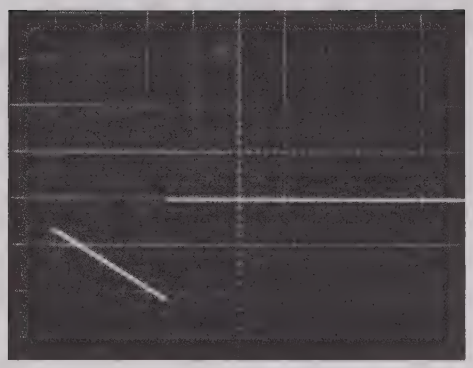


Figure 4-18. Waveform Pattern - Junction of R53 & CR13-CR14, and GND

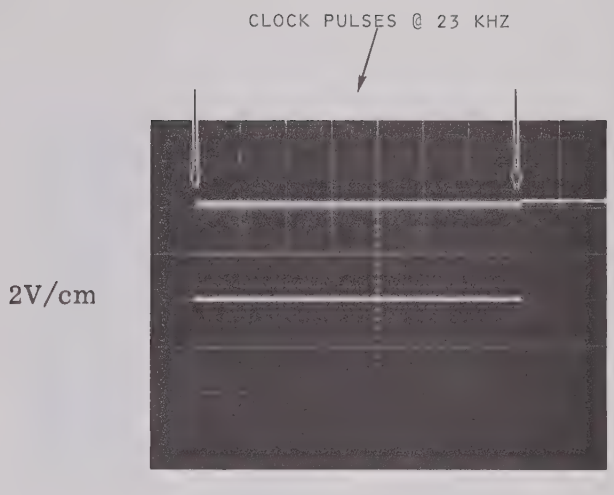


Figure 4-19. Waveform Pattern - TP1 and GND

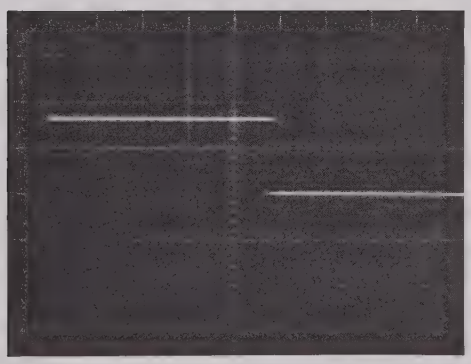


Figure 4-20. Waveform Pattern - TP2 and GND

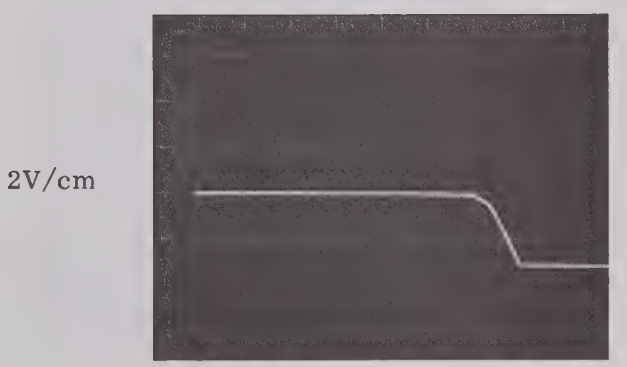
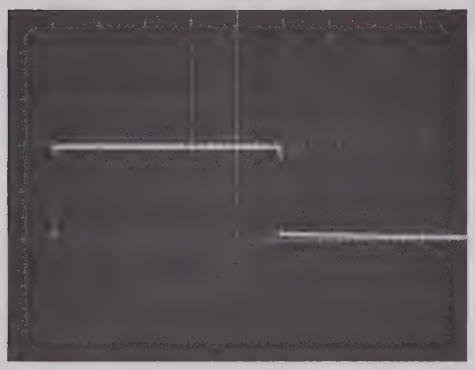


Figure 4-21. Waveform Pattern - Junction of R110 & Collector of Q52, and GND

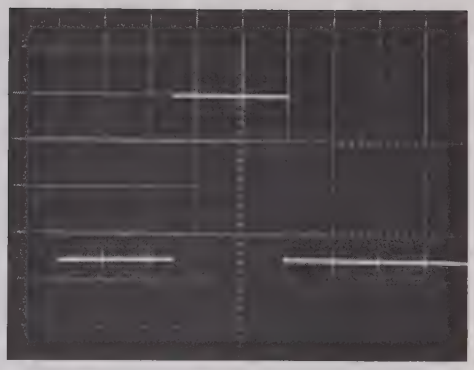
1V/cm



2ms/cm

Figure 4-22. Waveform Pattern - Junction of R112 & Base of Q50, and GND

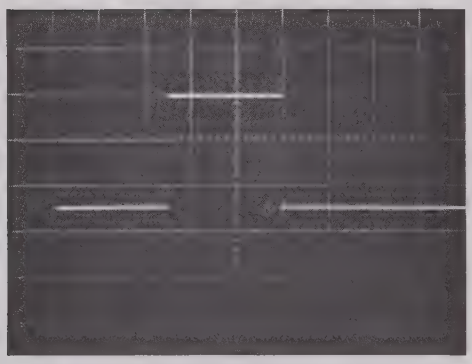
5V/cm



2ms/cm

Figure 4-23. Waveform Pattern - Junction of R50 & Collector of Q43, and GND

2V/cm

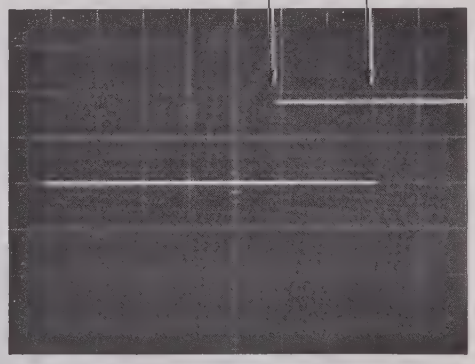


2ms/cm

Figure 4-24. Waveform Pattern - Junction of R147 & R152 and GND

CLOCK PULSES @ 23 KHZ

2V/cm



2ms/cm

Figure 4-25. Waveform Pattern - Terminal 14 of A16 and GND

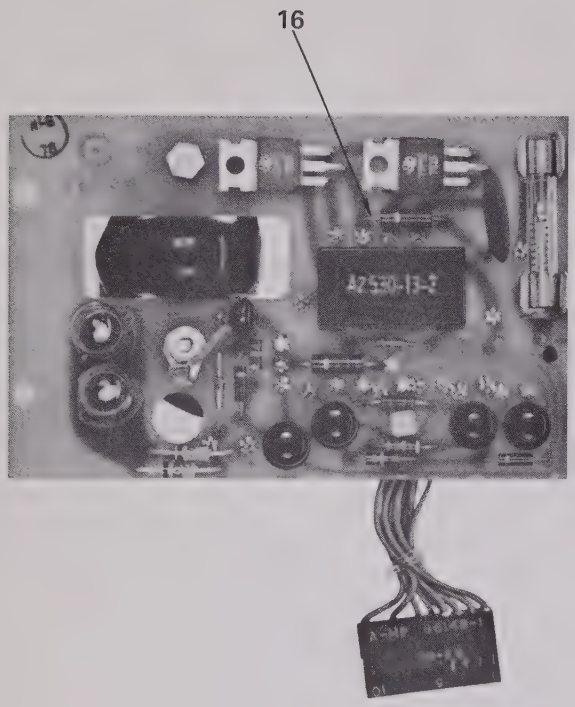


Figure 4-26. Battery Option Circuit Test Location

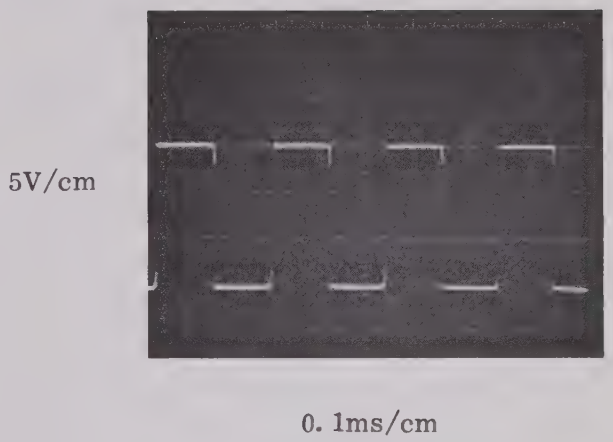


Figure 4-27. Waveform Pattern - Junction of R15 & Emitter of Q1,and GND

CHAPTER V

PARTS LIST

This chapter provides a list of electrical and electronic parts for the Series LX-2 Digital Multifunction Meter. The parts are listed alpha-numerically by reference designation in the REF DESIG column. The ZONE column lists the grid coordinates which locate the designated part on the accompanying illustration. Manufacturers of all components called out in the parts list are referred to by their Manufacturer's five-digit code number. Manufacturers and their codes are listed below.

Code	Manufacturer
00779	Amp, Inc. P.O. Box 3608 Harrisburg, PA 17105
01295	Texas Instruments, Inc. 13500 No. Central Expressway Dallas, TX 75231
02660	Amphenal Corporation 2801 So. 25th Avenue Broadview, IL 60153
03607	Radio Corporation of America 2700 W. Olive Avenue Burbank, CA 91505
03626	Non-Linear Systems, Inc. P.O. Box N Del Mar, CA 92014
03730	Gould Electric Co 3707 W. Touhy Avenue Lincolnwood, IL 60045
03888	Pyrofilm Corporation 60 So. Jefferson Road Whippany, NJ 07981
04713	Motorola, Inc. 5005 East McDowell Road Phoenix, AZ 85008

Code	Manufacturer
06751	Corning Components, Inc. 5540 W. Osborn Road Phoenix, AZ 85019
07263	Fairchild Camera & Instrument, Corp. 313 Bayshore Frontage Road Mountain View, CA 94040
07910	Continental Device Corporation 12515 Charden Hawthorne, CA 90250
11237	Chicago Telephone of California, Inc. 1010 Sycamore Avenue South Pasadena, CA 91031
12040	National Semiconductor Corporation P.O. Box 443 Danbury, CT 06810
12300	Potter and Brumfield Canada, Ltd. 135 Oxford Street Guelph, Ontario, Canada
12406	Elpac Components 18651 Von Karman Avenue Irvine, CA 92664
18324	Signetics Corporation 811 East Argues Avenue Sunnyvale, CA 94086

Code	Manufacturer
18722	Radio Corporation of America Crestwood Road Mountaintop, PA 18707
26806	American Zettler, Inc. 697 Randolph Avenue Costa Mesa, CA 92626
71590	Centralab Electronics 5757 No. Green Bay Avenue Milwaukee, WI 53201
71744	Chicago Miniature Lamp Works 4433 Ravenswood Avenue Chicago, IL 60640
73138	Beckman Instruments, Inc. 2500 Harbor Blvd. Fullerton, CA 92634
73445	Amperex Electronics Co. 230 Duffy Avenue Hicksville, L.I., NY 11801
75915	Littlefuse, Inc. 800 E. Northwest Highway Des Plaines, IL 60016
80183	Sprague Products 99 Marshall Street North Adams, MA 01247
82389	Switchcraft, Inc. 5527 No. Elston Avenue Chicago, IL 60630
82484	Sprague Devices, Inc. Huron & Frank Street Michigan, IN
84171	Arco Electronics, Inc. Community Drive Great Neck, NY 11022
91418	Radio Materials Co. 4242 W. Bryn Mawr Chicago, IL 60646

MAIN BOARD ASSEMBLY
(P/N 35-32)

with

PRINT OPTION ASSEMBLY
(P/N 35-56)

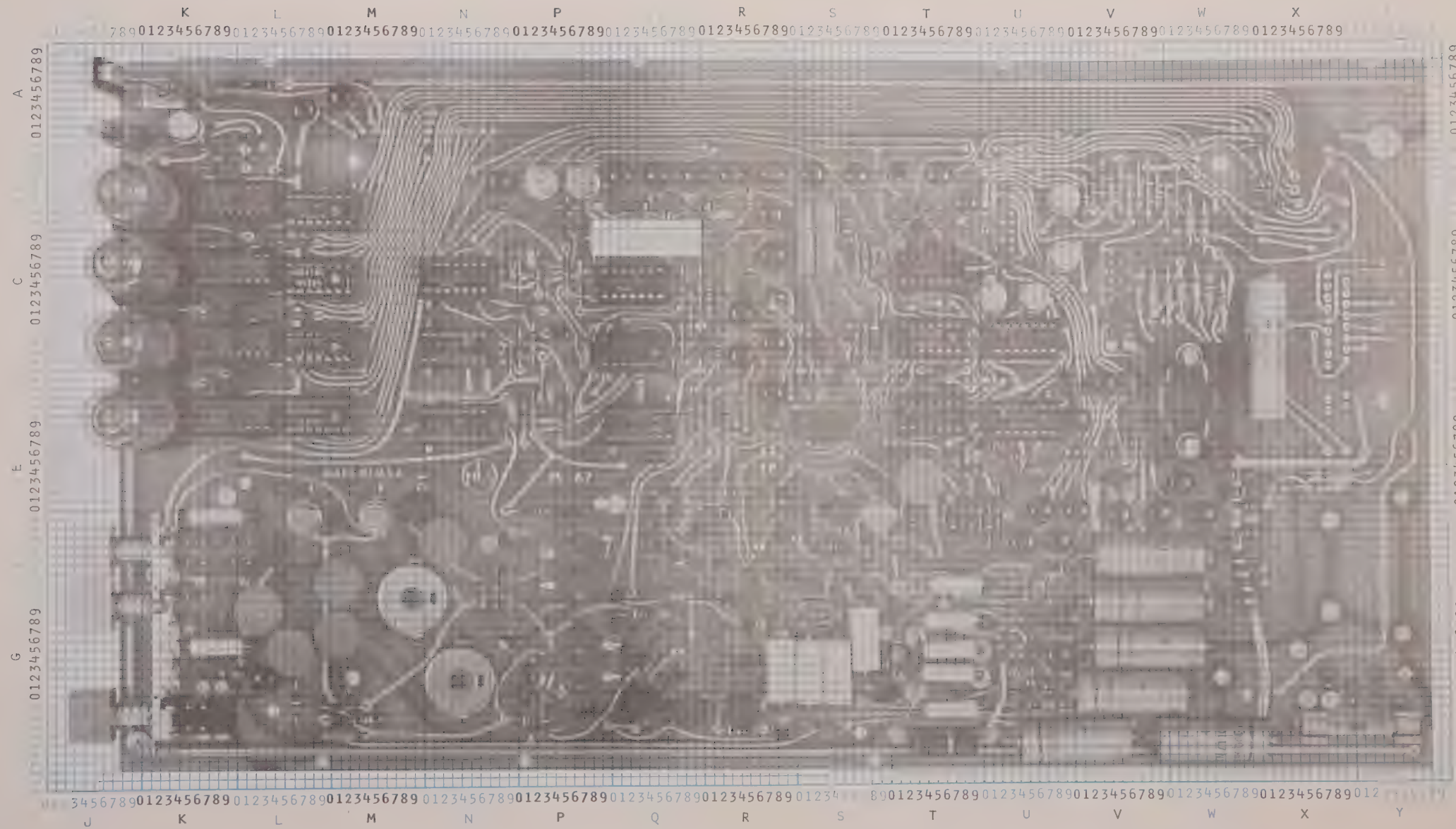


Figure 5-1. Main Board Assembly with Print Option Assembly

MAIN BOARD ASSEMBLY, P/N 35-32 (Figure 5-1)

ZONE	REF DESIG	PART NO.	DESCRIPTION	MFG CODE	QTY PER ASSY
C5N3	A1	SN7400N	Quadruple 2-Input Positive NAND Gate	01295	5
E9N3	A2	SN7400N	Quadruple 2-Input Positive NAND Gate	01295	REF
D8U4	A3	SN7400N	Quadruple 2-Input Positive NAND Gate	01295	REF
C4Q2	A4	SN7400N	Quadruple 2-Input Positive NAND Gate	01295	REF
E9Q3	A5	SN7400N	Quadruple 2-Input Positive NAND Gate	01295	REF
D7N3	A6	SN7420N	Dual 4-Input Positive NAND Gate	01295	1
B3K9	A7	N7441B	Decoder/Driver	18324	4
C6K9	A8	N7441B	Decoder/Driver	18324	REF
D8K9	A9	N7441B	Decoder/Driver	18324	REF
D0K9	A10	N7441B	Decoder/Driver	18324	REF
D8T4	A11	SN7473N	Dual J-K Master Slave Flip-Flop	01295	2
D7Q2	A12	SN7473N	Dual J-K Master Slave Flip-Flop	01295	REF
B2L8	A13	SN7490N	Decade Counter	01295	4
C5L8	A14	SN7490N	Decade Counter	01295	REF
D7L8	A15	SN7490N	Decade Counter	01295	REF
D0L8	A16	SN7490N	Decade Counter	01295	REF
C6T4	A17	SN15830N	Dual 4-Input NAND/NOR Gate	01295	1
F9L7	A18	LM301A	Amplifier	12040	3
F9M5	A19	LM301A	Amplifier	12040	REF
F9S9	A20	LM301A	Amplifier	12040	REF
E2L5	C1	DD300	Capacitor, 30 pF, 1 KV	71590	3
E2M1	C2	DD300	Capacitor, 30 pF, 1 KV	71590	REF
D2P3	C3	JL150	Capacitor, 150 pF, 1 KV, 10%	91418	6
C7P1	C4	JL150	Capacitor, 150 pF, 1 KV, 10%	91418	REF
D1N9	C5	JL150	Capacitor, 150 pF, 1 KV, 10%	91418	REF
D7P7	C6	JL150	Capacitor, 150 pF, 1 KV, 10%	91418	REF
B1R2	C7	JL150	Capacitor, 150 pF, 1 KV, 10%	91418	REF
E2S8	C8	DD080	Capacitor, 8 pF, 1 KV, 10%	71590	1
G9P4	C9	DD102	Capacitor, 0.001 μF, 1 KV	71590	1
C9S3	C10	CM20E182F	Capacitor, 1800 pF, 500V, 1%	84171	2
C9S1	C11	CM20E182F	Capacitor, 1800 pF, 500V, 1%	84171	REF
F6R0	C12	5002-010	Capacitor, 0.002 μF, 500V, 20%	03626	3
H7Q1	C13	5002-010	Capacitor, 0.002 μF, 500V, 20%	03626	REF
G1U7	C14	5002-010	Capacitor, 0.002 μF, 500V, 20%	03626	REF
C4R2	C15	DDM103	Capacitor, 0.01 μF, 150V, 10%	91418	2
F0S8	C16	DDM103	Capacitor, 0.01 μF, 150V, 10%	91418	REF
G8T6	C17	C281AB/A10K	Capacitor, 0.01 μF, 250V, 10%	73445	2
H8T6	C18	C281AB/A10K	Capacitor, 0.01 μF, 250V, 10%	73445	REF
B2S9	C19	DDM203	Capacitor, 0.02 μF, 150V, 10%	91418	1
F9K8	C20	C281AB/A22K	Capacitor, 0.022 μF, 250V, 10%	73445	5
F2T7	C21	C281AB/A22K	Capacitor, 0.022 μF, 250V, 10%	73445	REF
G5T6	C22	C281AB/A22K	Capacitor, 0.022 μF, 250V, 10%	73445	REF
G2T6	C23	C281AB/A22K	Capacitor, 0.022 μF, 250V, 10%	73445	REF
D7S2	C24	UK20-503	Capacitor, 0.05 μF, 20V, 20%	71590	1
G2R8	C25	C281CH/A470K	Capacitor, 0.47 μF, 100V, 10%	73445	4
G2S1	C26	C281CH/A470K	Capacitor, 0.47 μF, 100V, 10%	73445	REF
G2S4	C27	C281CH/A470K	Capacitor, 0.47 μF, 100V, 10%	73445	REF
G6S7	C28	C281CH/A470K	Capacitor, 0.47 μF, 100V, 10%	73445	REF
C9Q3	C29	C281AB/B1M	Capacitor, 1 μF, 250V, 5%	73445	1
E5Q5	C30	TSD2-20-106	Capacitor, 10 μF, 20V	06751	4
E0S4	C31	5002-016	Capacitor, 10 μF, 20V, 10%	03626	2
F5S7	C32	5002-016	Capacitor, 10 μF, 20V, 10%	03626	REF

MAIN BOARD ASSEMBLY, P/N 35-32 (Figure 5-1) [Con't]

ZONE	REF DESIG	PART NO.	DESCRIPTION	MFG CODE	QTY PER ASSY
F6S3	C33	TSD2-20-106	Capacitor, 10 μF, 20V	06751	REF
G3S9	C34	TSD2-20-106	Capacitor, 10 μF, 20V	06751	REF
D7R0	C35	TSD2-20-106	Capacitor, 10 μF, 20V	06751	REF
D7X1	C36	TVA1505	Capacitor, 12 μF, 250V	80183	1
E3V4	C37	TSD3-6-476	Capacitor, 47 μF, 6V	06751	1
F5V8	C38	ET471X025A01	Capacitor, 470 μF, 25V	73445	2
G9V8	C39	ET471X025A01	Capacitor, 470 μF, 25V	73445	REF
G5V8	C40	ET102X010P01	Capacitor, 1000 μF, 10V	73445	4
G0V6	C41	ET102X010P01	Capacitor, 1000 μF, 10V	73445	REF
H5V0	C42	ET102X010P01	Capacitor, 1000 μF, 10V	73445	REF
H5W5	C43	ET102X010P01	Capacitor, 1000 μF, 10V	73445	REF
G5K8	C53	C281AB/A22K	Capacitor, 0.022 μF, 250V, 10%	73445	REF
F1Q7	C54	JL150	Capacitor, 150 pF, 1 KV, 10%	91418	REF
F2R6	C55	DD300	Capacitor, 30 pF, 1 KV	71590	REF
C3P6	CR1	5003-002	Diode	03626	9
D8S1	CR2	5003-002	Diode	03626	REF
D3P2	CR3	5003-002	Diode	03626	REF
C5P0	CR4	5003-002	Diode	03626	REF
D7S3	CR5	5003-002	Diode	03626	REF
G8P6	CR6	5003-002	Diode	03626	REF
D0S6	CR7	5003-002	Diode	03626	REF
D0S8	CR8	5003-002	Diode	03626	REF
E0R1	CR9	5003-005	Diode	03626	6
F1R7	CR10	5003-005	Diode	03626	REF
F0S2	CR11	5003-005	Diode	03626	REF
G9S2	CR12	5003-005	Diode	03626	REF
G8S2	CR13	5003-005	Diode	03626	REF
G7S2	CR14	5003-005	Diode	03626	REF
G4K8	CR15	1N458	Diode	04713	6
G2K8	CR16	1N458	Diode	04713	REF
G0S9	CR17	1N458	Diode	04713	REF
H9S9	CR18	1N458	Diode	04713	REF
H7M2	CR19	See Note 1	Diode (Matched with R151)		1
F8L6	CR20	1N914	Diode	07910	3
F7P2	CR21	1N914	Diode	07910	REF
G7Q8	CR22	1N914	Diode	07910	REF
C3W1	CR23	1N4005	Diode	04713	10
C3V8	CR24	1N4005	Diode	04713	REF
C4W3	CR25	1N4005	Diode	04713	REF
C3W0	CR26	1N4005	Diode	04713	REF
B1W2	CR27	1N4005	Diode	04713	REF
B0W4	CR28	1N4005	Diode	04713	REF
C3W4	CR29	1N4005	Diode	04713	REF
C2W6	CR30	1N4005	Diode	04713	REF
E2X7	CR31	1N4005	Diode	04713	REF
E4X8	CR32	1N4005	Diode	04713	REF
F2W8	CR33	1N5248B	Diode, Zener	04713	2
F3W8	CR34	1N5248B	Diode, Zener	04713	REF
B7P6	CR58	5003-002	Diode	03626	REF
G9U6	CR59	1N458	Diode	04713	REF
G4U5	CR60	1N458	Diode	04713	REF
A1J5	DS1	39-66	Lamp, Indicator	03626	1

MAIN BOARD ASSEMBLY, P/N 35-32 (Figure 5-1) [Con't]

ZONE	REF DESIG	PART NO.	DESCRIPTION	MFG CODE	QTY PER ASSY
A7J5	DS2	CM26-305	Lamp, Indicator	71744	3
A7J3	DS3	CM26-305	Lamp, Indicator	71744	REF
A7J4	DS4	CM26-305	Lamp, Indicator	71744	REF
H6Y0	F1	313.500	Fuse, 3AG, 1/2A, Slo-Blo	75915	1
G0Y4	J5	AC3G	Receptacle, AC (Not shown)	82389	1
A1K4	Q1	2N1893	Transistor	01295	5
B5P7	Q2	2N3440	Transistor	18722	1
B4U9	Q5	2N1893	Transistor	01295	REF
C3U1	Q6	2N1893	Transistor	01295	REF
C3U6	Q7	2N1893	Transistor	01295	REF
C7U9	Q8	2N1893	Transistor	01295	REF
A4M1	Q9	2N3569	Transistor	07263	23
A3L6	Q10	2N3569	Transistor	07263	REF
B6S6	Q11	2N3569	Transistor	07263	REF
B6T5	Q12	2N3569	Transistor	07263	REF
B6S2	Q13	2N3569	Transistor	07263	REF
B6R7	Q14	2N3569	Transistor	07263	REF
B2R7	Q15	2N3569	Transistor	07263	REF
B6R3	Q16	2N3569	Transistor	07263	REF
B6Q1	Q17	2N3569	Transistor	07263	REF
B6Q5	Q18	2N3569	Transistor	07263	REF
B6Q9	Q19	2N3569	Transistor	07263	REF
C1R4	Q20	2N3569	Transistor	07263	REF
D8R7	Q21	2N3569	Transistor	07263	REF
G4U8	Q22	2N3569	Transistor	07263	REF
D7R4	Q23	2N3569	Transistor	07263	REF
B3T8	Q24	2N3569	Transistor	07263	REF
E0V0	Q25	2N3569	Transistor	07263	REF
F6U8	Q26	2N3569	Transistor	07263	REF
F6U4	Q27	2N3569	Transistor	07263	REF
E0U6	Q28	2N3569	Transistor	07263	REF
F9V5	Q29	2N3569	Transistor	07263	REF
F9W4	Q30	2N3569	Transistor	07263	REF
E3W1	Q31	2N3569	Transistor	07263	REF
C7R7	Q32	2N3645	Transistor	07263	6
D2R7	Q33	2N3645	Transistor	07263	REF
G2L3	Q34	2N3645	Transistor	07263	REF
G8U9	Q35	2N3645	Transistor	07263	REF
F9V9	Q36	2N3645	Transistor	07263	REF
D1W2	Q37	TIP32/2N3741	Transistor	01295	1
F3R9	Q38	2N3819	Transistor	01295	2
F7R8	Q39	2N3819	Transistor	01295	REF
C3R7	Q40	2N3904	Transistor	01295	11
B6T1	Q41	2N3904	Transistor	01295	REF
D9P4	Q42	2N3904	Transistor	01295	REF
G4N8	Q43	2N3904	Transistor	01295	REF
E1R8	Q44	2N3904	Transistor	01295	REF
F4R1	Q45	2N3904	Transistor	01295	REF
F4Q7	Q46	2N3904	Transistor	01295	REF
H6R8	Q47	2N3904	Transistor	01295	REF
H8P7	Q48	2N3904	Transistor	01295	REF
G4Q3	Q49	2N3904	Transistor	01295	REF

MAIN BOARD ASSEMBLY, P/N 35-32 (Figure 5-1) [Con't]

ZONE	REF DESIG	PART NO.	DESCRIPTION	MFG CODE	QTY PER ASSY
F0Q0	Q50	2N3904	Transistor	01295	REF
E0P6	Q51	2N3906	Transistor	04713	6
G7R4	Q52	2N3906	Transistor	04713	REF
G3R4	Q53	2N3906	Transistor	04713	REF
G2Q7	Q54	2N3906	Transistor	04713	REF
F0R2	Q55	2N3906	Transistor	04713	REF
G2P1	Q56	2N3906	Transistor	04713	REF
F1T0	Q57	5003-015	Transistor	03626	1
F6N6	Q58	2N4977	Transistor	04713	1
F2L6	Q59	TD101	Transistor	80183	4
H8Q8	Q60	TD101	Transistor	80183	REF
E9S3	Q61	TD101	Transistor	80183	REF
E0M9	Q62	TD401	Transistor	80183	2
H9Q3	Q63	TD401	Transistor	80183	REF
B5N8	Q102	2N3645	Transistor	07363	REF
B5P2	Q103	40527/40530	Triac	03607	1
H8R4	Q104	TD101	Transistor	80183	REF
A5L3	R1	RC07GF220J	Resistor, 22Ω, 1/4W, 5%		3
G9W8	R2	RC07GF220J	Resistor, 22Ω, 1/4W, 5%		REF
F6W6	R3	RC07GF220J	Resistor, 22Ω, 1/4W, 5%		REF
D1R0	R4	RC07GF101J	Resistor, 100Ω, 1/4W, 5%		2
F8S3	R5	RC07GF331J	Resistor, 330Ω, 1/4W, 5%		2
F3S4	R6	RC07GF331J	Resistor, 330Ω, 1/4W, 5%		REF
G2N4	R7	P115R101	Potentiometer, 100Ω	11237	1
F0M8	R8	5115R501	Potentiometer, 500Ω	11237	1
F3P6	R9	U201R103B	Potentiometer, 10K	11237	1
G3P6	R10	U201R104B	Potentiometer, 100K	11237	1
D5T6	R11	RC07GF102J	Resistor, 1K, 1/4W, 5%		3
F0W8	R12	RC07GF102J	Resistor, 1K, 1/4W, 5%		REF
F5W7	R13	RC07GF102J	Resistor, 1K, 1/4W, 5%		REF
C8N9	R14	RC07GF202J	Resistor, 2K, 1/4W, 5%		18
C5P5	R15	RC07GF202J	Resistor, 2K, 1/4W, 5%		REF
C6N8	R16	RC07GF202J	Resistor, 2K, 1/4W, 5%		REF
C1P0	R17	RC07GF202J	Resistor, 2K, 1/4W, 5%		REF
B2S4	R18	RC07GF202J	Resistor, 2K, 1/4W, 5%		REF
D8S6	R19	RC07GF202J	Resistor, 2K, 1/4W, 5%		REF
D8Q9	R20	RC07GF202J	Resistor, 2K, 1/4W, 5%		REF
E6T0	R21	RC07GF202J	Resistor, 2K, 1/4W, 5%		REF
E2U3	R22	RC07GF202J	Resistor, 2K, 1/4W, 5%		REF
E0U3	R23	RC07GF202J	Resistor, 2K, 1/4W, 5%		REF
E0T7	R24	RC07GF202J	Resistor, 2K, 1/4W, 5%		REF
F8T9	R25	RC07GF202J	Resistor, 2K, 1/4W, 5%		REF
E0U0	R26	RC07GF202J	Resistor, 2K, 1/4W, 5%		REF
F8U0	R27	RC07GF202J	Resistor, 2K, 1/4W, 5%		REF
E0T5	R28	RC07GF202J	Resistor, 2K, 1/4W, 5%		REF
F8T6	R29	RC07GF202J	Resistor, 2K, 1/4W, 5%		REF
E2Q6	R30	RC07GF202J	Resistor, 2K, 1/4W, 5%		REF
H8Q6	R31	RC07GF202J	Resistor, 2K, 1/4W, 5%		REF
E2R3	R32	RC07GF392J	Resistor, 3.9K, 1/4W, 5%		1
D0P5	R33	RC07GF512J	Resistor, 5.1K, 1/4W, 5%		21
E9P4	R34	RC07GF512J	Resistor, 5.1K, 1/4W, 5%		REF
D7P0	R35	RC07GF512J	Resistor, 5.1K, 1/4W, 5%		REF

MAIN BOARD ASSEMBLY, P/N 35-32 (Figure 5-1) [Con't]

ZONE	REF DESIG	PART NO.	DESCRIPTION	MFG CODE	QTY PER ASSY
D6N9	R36	RC07GF512J	Resistor, 5.1K, 1/4W, 5%		REF
C5P3	R37	RC07GF512J	Resistor, 5.1K, 1/4W, 5%		REF
D8S0	R38	RC07GF512J	Resistor, 5.1K, 1/4W, 5%		REF
B0T3	R39	RC07GF512J	Resistor, 5.1K, 1/4W, 5%		REF
E9N8	R40	RC07GF512J	Resistor, 5.1K, 1/4W, 5%		REF
E9P0	R41	RC07GF512J	Resistor, 5.1K, 1/4W, 5%		REF
D8S7	R42	RC07GF512J	Resistor, 5.1K, 1/4W, 5%		REF
D4T4	R44	RC07GF512J	Resistor, 5.1K, 1/4W, 5%		REF
D3T6	R45	RC07GF512J	Resistor, 5.1K, 1/4W, 5%		REF
C4Q9	R46	RC07GF512J	Resistor, 5.1K, 1/4W, 5%		REF
C2Q8	R47	RC07GF512J	Resistor, 5.1K, 1/4W, 5%		REF
D7P8	R48	RC07GF512J	Resistor, 5.1K, 1/4W, 5%		REF
C4Q7	R49	RC07GF512J	Resistor, 5.1K, 1/4W, 5%		REF
F1N9	R50	RC07GF101J	Resistor, 100Ω, 1/4W, 5%		REF
E0P1	R51	RC07GF512J	Resistor, 5.1K, 1/4W, 5%		REF
G7Q3	R52	RC07GF512J	Resistor, 5.1K, 1/4W, 5%		REF
E8S6	R53	RC07GF512J	Resistor, 5.1K, 1/4W, 5%		REF
D5S5	R54	RC07GF512J	Resistor, 5.1K, 1/4W, 5%		REF
D0R2	R55	RC07GF752J	Resistor, 7.5K, 1/4W, 5%		1
D1Q8	R56	RC07GF103J	Resistor, 10K, 1/4W, 5%		13
D8P1	R57	RC07GF103J	Resistor, 10K, 1/4W, 5%		REF
C5P2	R58	RC07GF103J	Resistor, 10K, 1/4W, 5%		REF
A0L1	R59	RC07GF103J	Resistor, 10K, 1/4W, 5%		REF
B6L6	R60	RC07GF103J	Resistor, 10K, 1/4W, 5%		REF
D0P1	R61	RC07GF103J	Resistor, 10K, 1/4W, 5%		REF
C5P8	R62	RC07GF103J	Resistor, 10K, 1/4W, 5%		REF
D7R1	R63	RC07GF103J	Resistor, 10K, 1/4W, 5%		REF
G7K8	R64	RC07GF103J	Resistor, 10K, 1/4W, 5%		REF
F1N7	R65	RC07GF103J	Resistor, 10K, 1/4W, 5%		REF
F8R0	R66	RC07GF103J	Resistor, 10K, 1/4W, 5%		REF
G7Q7	R67	RC07GF302J	Resistor, 3K, 1/4W, 5%		1
H6P2	R68	RC07GF103J	Resistor, 10K, 1/4W, 5%		REF
E0W8	R69	RC07GF103J	Resistor, 10K, 1/4W, 5%		REF
B6K8	R70	RC07GF153J	Resistor, 15K, 1/4W, 5%		4
C9K9	R71	RC07GF153J	Resistor, 15K, 1/4W, 5%		REF
C1K9	R72	RC07GF153J	Resistor, 15K, 1/4W, 5%		REF
D3K9	R73	RC07GF153J	Resistor, 15K, 1/4W, 5%		REF
F0U7	R74	RC07GF113J	Resistor, 11K, 1/4W, 5%		2
G0U5	R75	RC07GF113J	Resistor, 11K, 1/4W, 5%		REF
C4S4	R76	RC07GF183J	Resistor, 18K, 1/4W, 5%		3
B3R1	R77	RC07GF183J	Resistor, 18K, 1/4W, 5%		REF
F9R8	R78	RC07GF183J	Resistor, 18K, 1/4W, 5%		REF
C8S8	R79	RC07GF203J	Resistor, 20K, 1/4W, 5%		13
B1T2	R80	RC07GF203J	Resistor, 20K, 1/4W, 5%		REF
B4X1	R81	RC07GF203J	Resistor, 20K, 1/4W, 5%		REF
B6X1	R82	RC07GF203J	Resistor, 20K, 1/4W, 5%		REF
B3X2	R83	RC07GF203J	Resistor, 20K, 1/4W, 5%		REF
B9X1	R84	RC07GF203J	Resistor, 20K, 1/4W, 5%		REF
B2T3	R85	RC07GF203J	Resistor, 20K, 1/4W, 5%		REF
B3T2	R86	RC07GF203J	Resistor, 20K, 1/4W, 5%		REF
D8Q7	R87	RC07GF203J	Resistor, 20K, 1/4W, 5%		REF
G6R1	R88	RC07GF203J	Resistor, 20K, 1/4W, 5%		REF

MAIN BOARD ASSEMBLY, P/N 35-32 (Figure 5-1) [Con't]

ZONE	REF DESIG	PART NO.	DESCRIPTION	MFG CODE	QTY PER ASSY
F6Q4	R89	RC07GF203J	Resistor, 20K, 1/4W, 5%		REF
B7L0	R90	RC07GF333J	Resistor, 33K, 1/4W, 5%		8
C8L6	R91	RC07GF333J	Resistor, 33K, 1/4W, 5%		REF
C0L6	R92	RC07GF333J	Resistor, 33K, 1/4W, 5%		REF
D4L1	R93	RC07GF333J	Resistor, 33K, 1/4W, 5%		REF
C6R5	R94	RC07GF333J	Resistor, 33K, 1/4W, 5%		REF
C3R0	R95	RC07GF333J	Resistor, 33K, 1/4W, 5%		REF
F8Q5	R96	RC07GF333J	Resistor, 33K, 1/4W, 5%		REF
B1Q6	R97	RC07GF393J	Resistor, 39K, 1/4W, 5%		1
C9T2	R98	RC07GF473J	Resistor, 47K, 1/4W, 5%		1
H9M1	R99	RC07GF513J	Resistor, 51K, 1/4W, 5%		2
C7S7	R100	RC07GF753J	Resistor, 75K, 1/4W, 5%		2
D8S4	R101	RC07GF753J	Resistor, 75K, 1/4W, 5%		REF
B8K8	R102	RC07GF513J	Resistor, 51K, 1/4W, 5%		REF
E9Q9	R103	RC07GF104J	Resistor, 100K, 1/4W, 5%		3
C4R1	R104	RC07GF104J	Resistor, 100K, 1/4W, 5%		REF
E9S1	R105	RC07GF104J	Resistor, 100K, 1/4W, 5%		REF
H9L6	R106	RC07GF124J	Resistor, 120K, 1/4W, 5%		1
F3U8	R107	RC07GF154J	Resistor, 150K, 1/4W, 5%		2
H9U5	R108	RC07GF154J	Resistor, 150K, 1/4W, 5%		REF
E7S0	R109	RC07GF184J	Resistor, 180K, 1/4W, 5%		1
F2R5	R110	RC07GF244J	Resistor, 240K, 1/4W, 5%		2
F3R6	R111	RC07GF244J	Resistor, 240K, 1/4W, 5%		REF
G8Q3	R112	RC07GF394J	Resistor, 390K, 1/4W, 5%		2
H6R4	R113	RC07GF914J	Resistor, 910K, 1/4W, 5%		1
H7P1	R114	RC07GF394J	Resistor, 390K, 1/4W, 5%		REF
F2Q8	R115	RC07GF514J	Resistor, 510K, 1/4W, 5%		1
F9R2	R116	RC07GF754J	Resistor, 750K, 1/4W, 5%		2
C6S6	R117	RC07GF105J	Resistor, 1M, 1/4W, 5%		6
H7S2	R120	RC07GF105J	Resistor, 1M, 1/4W, 5%		REF
H9P1	R121	RC07GF105J	Resistor, 1M, 1/4W, 5%		REF
H9Q5	R122	RC07GF105J	Resistor, 1M, 1/4W, 5%		REF
G9T2	R123	RC07GF105J	Resistor, 1M, 1/4W, 5%		REF
G3T2	R124	RC07GF105J	Resistor, 1M, 1/4W, 5%		REF
G5R2	R125	RC07GF155J	Resistor, 1.5M, 1/4W, 5%		2
G6R0	R126	RC07GF155J	Resistor, 1.5M, 1/4W, 5%		REF
G0P2	R127	RC07GF205J	Resistor, 2M, 1/4W, 5%		2
F2S6	R128	RC07GF305J	Resistor, 3M, 1/4W, 5%		1
H8P2	R129	RC07GF515J	Resistor, 5.1M, 1/4W, 5%		1
F1T4	R130	RC07GF106J	Resistor, 10M, 1/4W, 5%		1
F9W8	R131	RL07S332G	Resistor, 3.3K, 1/4W, 2%		1
F7W8	R132	RL07S133G	Resistor, 13K, 1/4W, 2%		1
C0S8	R133	RL07S153G	Resistor, 15K, 1/4W, 2%		3
B2Q9	R134	RL07S153G	Resistor, 15K, 1/4W, 2%		REF
B3Q3	R135	RL07S153G	Resistor, 15K, 1/4W, 2%		REF
B0S5	R136	RL07S243G	Resistor, 24K, 1/4W, 2%		1
F7T2	R137	RL07S303G	Resistor, 30K, 1/4W, 2%		2
F8S5	R138	RL07S303G	Resistor, 30K, 1/4W, 2%		REF
G6T1	R139	RL07S473G	Resistor, 47K, 1/4W, 2%		1
B2Q2	R140	RL07S753G	Resistor, 75K, 1/4W, 2%		1
E2W7	R141	RC20GF101J	Resistor, 100Ω, 1/2W, 5%		2
E3W7	R142	RC20GF101J	Resistor, 100Ω, 1/2W, 5%		REF

MAIN BOARD ASSEMBLY, P/N 35-32 (Figure 5-1) [Con't]

ZONE	REF DESIG	PART NO.	DESCRIPTION	MFG CODE	QTY PER ASSY
C7W7	R143	RC07GF205J	Resistor, 2M, 1/4W, 5%		REF
H5T6	R145	RC42GF105J	Resistor, 1M, 2W, 5%		1
H6M1	R146	RN60C3571F	Resistor, 3.57K, 1/8W, 1%		1
F0N6	R147	RN60C4023B	Resistor, 402K, 1/8W, 0.1%		1
F9S1	R148	RN60D2004F	Resistor, 2M, 1/2W, 1%		2
F4T6	R149	RN60D2004F	Resistor, 2M, 1/2W, 1%		REF
E3T3	R150	PW1620812R0M	Resistor, 812Ω, 0.05%	03626	1
F7M1	R151	See Note 1	Resistor, (Matched with CR19)		1
F6N2	R152	PW162040600M	Resistor, 4.06K, 0.05%	03626	1
G5L5	R153	PW162049500M	Resistor, 4.95K, 0.05%	03626	1
G9L2	R154	PW162010001M	Resistor, 10K, 0.05%	03626	1
F2M1	R155	PW162020001M	Resistor, 20K, 0.05%	03626	1
B4R5	R215	RC07GF333J	Resistor, 33K, 1/4W, 5%		REF
B2P6	R216	RC07GF203J	Resistor, 20K, 1/4W, 5%		REF
B2N8	R217	RC07GF201J	Resistor, 200Ω, 1/4W, 5%		REF
B1P4	R218	RC07GF512J	Resistor, 5.1K, 1/4W, 5%		REF
B0P5	R219	RC07GF203J	Resistor, 20K, 1/4W, 5%		REF
G1R4	R220	RC07GF754J	Resistor, 750K, 1/4W, 5%		REF
D3S3	R221	RC07GF201J	Resistor, 200Ω, 1/4W, 5%		REF
F4K7	S1	35-40	Switch Assembly, Filter	03626	1
F0K6	S2	35-41	Switch Assembly	03626	2
H8K6	S3	35-41	Switch Assembly	03626	REF
F3X9	T1	D304	Transformer (Not Shown) - If Battery Option Assembly is included, P/N is D302	03626	1
D0J7	V1	ZM1000	Tube, Indicator	73445	4
D8J7	V2	ZM1000	Tube, Indicator	73445	REF
C7J7	V3	ZM1000	Tube, Indicator	73445	REF
B4J7	V4	ZM1000	Tube, Indicator	73445	REF

NOTE

(1) Diode CR19 and Resistor R151 are a matched set and must be replaced as a matched set. Order by NLS part number 35-43.

PRINT OPTION ASSEMBLY, P/N 35-56 (Figure 5-1)

ZONE	REF DESIG	PART NO.	DESCRIPTION	MFG CODE	QTY PER ASSY
D0T4	A21	SN7400N	Quadruple 2-Input Positive NAND Gate	01295	2
E9U4	A22	SN7400N	Quadruple 2-Input Positive NAND Gate	01295	REF
E4U6	C50	DDM203	Capacitor, 0.02 μF, 150V	91418	1
D3U9	C51	DDM103	Capacitor, 0.01 μF, 150V	91418	2
D3V6	C52	DDM103	Capacitor, 0.01 μF, 150V	91418	REF
B4T1	C56	JL470	Capacitor, 470 pF, 1 KV, 10% (Reverse side)	91418	1
B4W1	CR50	5003-002	Diode	03626	8
B3V8	CR51	5003-002	Diode	03626	REF
B4V6	CR52	5003-002	Diode	03626	REF
B4V9	CR53	5003-002	Diode	03626	REF
B5V5	CR54	5003-002	Diode	03626	REF
B4V7	CR55	5003-002	Diode	03626	REF
B3W0	CR56	5003-002	Diode	03626	REF
B4V4	CR57	5003-002	Diode	03626	REF
C9Y5	J9	57-40500	Connector (Not shown)	02660	1
E9V1	Q100	2N3569	Transistor	07263	2
D4V3	Q101	2N3569	Transistor	07263	REF
C8T5	R200	RC07GF512J	Resistor, 5.1K, 1/4W, 5%		4
E6V1	R201	RC07GF512J	Resistor, 5.1K, 1/4W, 5%		REF
E5V0	R202	RC07GF473J	Resistor, 47K, 1/4W, 5%		1
E5T6	R203	RC07GF202J	Resistor, 2K, 1/4W, 5%		2
E4T9	R204	RC07GF202J	Resistor, 2K, 1/4W, 5%		REF
D3U8	R205	RC07GF512J	Resistor, 5.1K, 1/4W, 5%		REF
E7V5	R206	RC07GF103J	Resistor, 10K, 1/4W, 5%		3
E7V4	R207	RC07GF103J	Resistor, 10K, 1/4W, 5%		REF
E5U3	R208	RC07GF203J	Resistor, 20K, 1/4W, 5%		4
D3V5	R209	RC07GF103J	Resistor, 10K, 1/4W, 5%		REF
E6U0	R210	RC07GF512J	Resistor, 5.1K, 1/4W, 5%		REF
B4V1	R211	RC07GF203J	Resistor, 20K, 1/4W, 5%		REF
B5V2	R212	RC07GF203J	Resistor, 20K, 1/4W, 5%		REF
B5V3	R213	RC07GF203J	Resistor, 20K, 1/4W, 5%		REF

FUNCTION SWITCHING ASSEMBLY
(P/N 35-24)

with

BATTERY OPTION ASSEMBLY
(P/N 35-47)

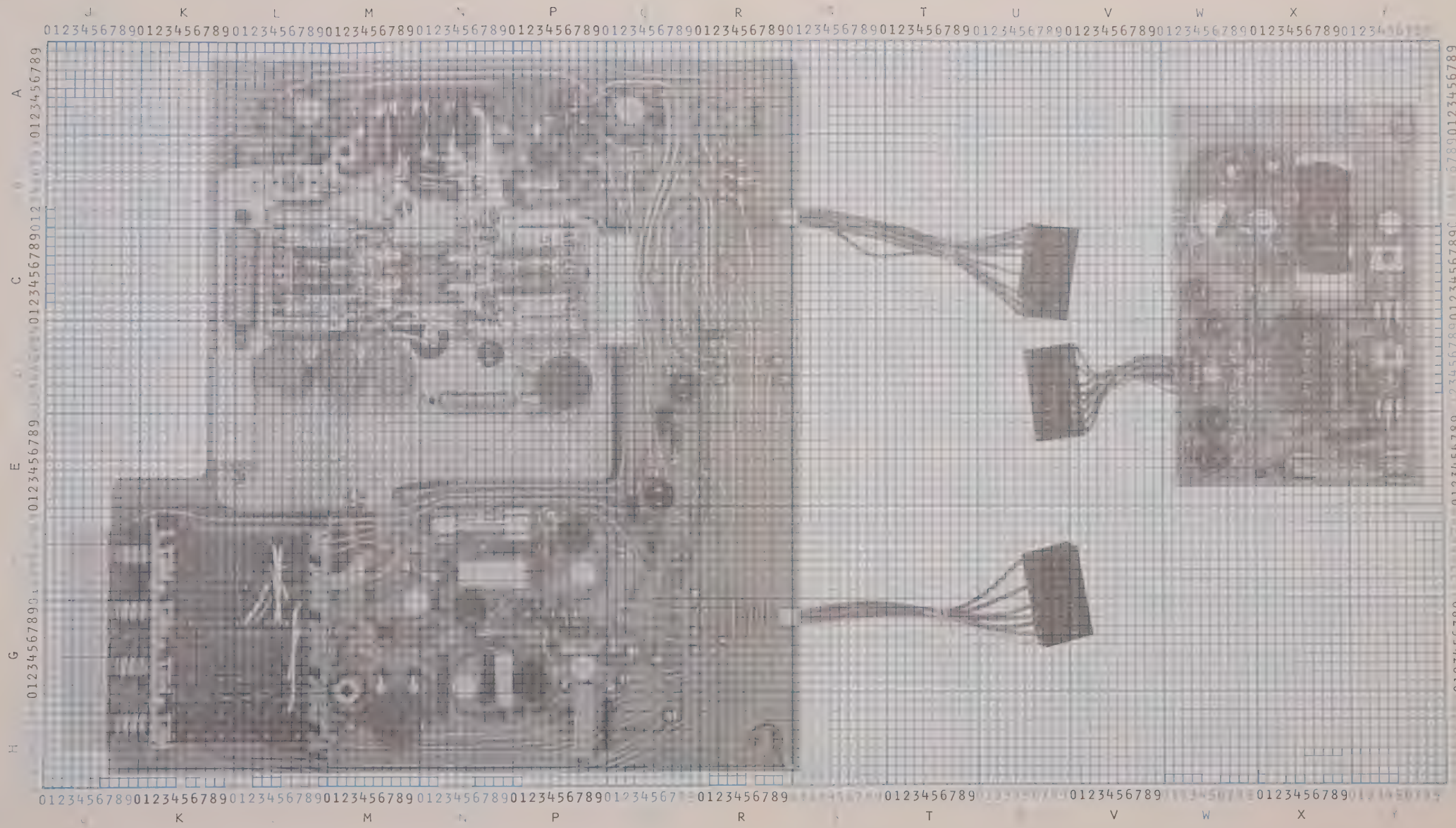


Figure 5-2. Function Switching Assembly with Battery Option Assembly

FUNCTION SWITCHING ASSEMBLY, P/N 35-24 (Figure 5-2)

ZONE	REF DESIG	PART NO.	DESCRIPTION	MFG CODE	QTY PER ASSY
A3L8	A1	LM301A	Amplifier	12040	2
A3Q3	A2	LM301A	Amplifier	12040	REF
B5L6	C1	402	Capacitor, 1.5 - 20 pF, 175V	84171	1
A2M8	C2	CM15C010D	Capacitor, 1 pF, 500V	84171	2
B7N1	C3	CM15C010D	Capacitor, 1 pF, 500V	84171	REF
A1N2	C4	CM15C100J	Capacitor, 10 pF, 500V	84171	1
B9P6	C5	DD300	Capacitor, 30 pF, 1 KV	71590	1
A1N5	C6	CM15E201F	Capacitor, 200 pF, 500V	84171	1
A3L2	C7	JL150	Capacitor, 150 pF, 1 KV	91418	2
A1P9	C8	JL150	Capacitor, 150 pF, 1 KV	91418	REF
G1N9	C9	C281AB/A22K	Capacitor, 0.022 μF, 250V	73445	1
D1L0	C10	C281CG/A220K*	Capacitor, 0.22 μF, 630V	73445	1
F3N8	C11	C281CH/A470K	Capacitor, 0.47 μF, 100V	73445	1
C4Q2	C12	C281AB/B1M	Capacitor, 1 μF, 250V	73445	1
E0Q3	C13	TSD2-20-106	Capacitor, 10 μF, 20V	06751	2
E9Q6	C14	TSD2-20-106	Capacitor, 10 μF, 20V	06751	REF
B7P4	C15	TSD3-6-476	Capacitor, 47 μF, 6V	06751	1
A0M5	C18	CM15C020D	Capacitor, 2 pF, 500V	84171	1
G7P5	CR1	1N458	Diode	04713	4
G7P7	CR2	1N458	Diode	04713	REF
G8P3	CR3	1N458	Diode	04713	REF
G9P2	CR4	1N458	Diode	04713	REF
B9L4	CR5	1N914	Diode	07910	4
B8L5	CR6	1N914	Diode	07910	REF
B6Q2	CR7	1N914	Diode	07910	REF
B5Q1	CR8	1N914	Diode	07910	REF
A1R3	CR9	5003-002	Diode	03626	2
A3R3	CR10	5003-002	Diode	03626	REF
F8N6	F2	361.010	Fuse, 8AG, 1/100A	75915	1
C5L9	K1	R40-E061-1	Relay	12300	2
C5P2	K2	R40-E061-1	Relay	12300	REF
F0U9	P1	86148-1	Connector	00779	2
C5U8	P2	86148-1	Connector	00779	REF
F7P7	Q1	TD101	Transistor	80183	1
G1P2	Q2	TD401	Transistor	80183	2
G9N5	Q3	TD401	Transistor	80183	REF
D3Q9	Q4	2N3569	Transistor	07263	1
E1Q6	Q5	2N3645	Transistor	07263	1
G7M6	Q6	2N3906	Transistor	04713	1
A4P1	R1	U201R101B	Potentiometer, 100Ω	11237	1
H8M8	R2	U201R501B	Potentiometer, 500Ω	11237	1
D3P6	R3	U201R503B	Potentiometer, 50K	11237	1
H7P7	R4	76P-R10K	Potentiometer, 10K	80053	1
G9K0	R5	76P-R200K	Potentiometer, 200K (Reverse side)	80053	2
F5K0	R6	76P-R200K	Potentiometer, 200K (Reverse side)	80053	REF
A1N6	R7	See Note 2	Resistor, 2K (Matched)		1
A1N3	R8	See Note 2	Resistor, 20K (Matched)		1
A1N0	R9	See Note 2	Resistor, 200K (Matched)		1
B3N1	R10	See Note 2	Resistor, 1M (Matched)		1
A0M7	R11	See Note 2	Resistor, 1M (Matched)		1
D5L5	R12	See Note 3	Resistor, 10K (Matched)		1

*Alternate is C280CG/A220K

FUNCTION SWITCHING ASSEMBLY, P/N 35-24 (Figure 5-2) [Con't]

ZONE	REF DESIG	PART NO.	DESCRIPTION	MFG CODE	QTY PER ASSY
D5M1	R13	See Note 3	Resistor, 90K (Matched)		1
D5M7	R14	See Note 3	Resistor, 900K (Matched)		1
F4P3	R15	RC07GF151J	Resistor, 150Ω, 1/4W, 5%		1
D9R2	R16	RC07GF102J	Resistor, 1K, 1/4W, 5%		3
F6Q5	R17	RC07GF102J	Resistor, 1K, 1/4W, 5%		REF
E8Q7	R18	RC07GF102J	Resistor, 1K, 1/4W, 5%		REF
A3P7	R19	RC07GF104J	Resistor, 100K, 1/4W, 5%		1
H8P4	R20	RC07GF244J	Resistor, 240K, 1/4W, 5%		1
F5N9	R21	RC07GF624J	Resistor, 620K, 1/4W, 5%		1
F0N2	R22	RC07GF205J	Resistor, 2M, 1/4W, 5%		3
F1M5	R23	RC07GF205J	Resistor, 2M, 1/4W, 5%		REF
F6P4	R24	RC07GF205J	Resistor, 2M, 1/4W, 5%		REF
F1N3	R25	RC07GF395J	Resistor, 3.9M, 1/4W, 5%		1
A0P8	R26	RC07GF106J	Resistor, 10M, 1/4W, 5%		2
A2Q6	R27	RC07GF106J	Resistor, 10M, 1/4W, 5%		REF
B6P4	R30	RN60C1102F	Resistor, 11K, 1/8W, 1%		1
H7Q0	R31	RN60C5622F	Resistor, 56.2K, 1/8W, 1%		1
G0N3	R32	RN60C9002F	Resistor, 90K, 1/8W, 1%		1
G5P7	R33	RN60C1003F	Resistor, 100K, 1/8W, 1%		1
B5P3	R34	RN60C2003F	Resistor, 200K, 1/8W, 1%		2
B3P3	R35	RN60C2003F	Resistor, 200K, 1/8W, 1%		REF
A2P5	R36	RN60E4991F	Resistor, 4.99K, 1/8W, 1%		1
G1N7	R37	RN60E1002F	Resistor, 10K, 1/8W, 1%		1
D1N6	R38	PME 70T2	Resistor, 8.981, 0.1%	03888	1
C5L1	R39	PME 75T9	Resistor, 1M, 1W, 1%	03888	1
G6K2	S1	35-39	Switch Assembly	03626	1

NOTES

(2) Resistors R7 thru R11 are a matched set and must be replaced as a matched set. Order by NLS part number 35-42.

(3) Resistors R12 thru R14 are a matched set and must be replaced as a matched set. Order by NLS part number 35-44.

BATTERY OPTION ASSEMBLY, P/N 35-47 (Figure 5-2)

ZONE	REF DESIG	PART NO.	DESCRIPTION	MFG CODE	QTY PER ASSY
	BT1-BT5	7.0 SCL	Cell, "NICAD" (Not shown)	03730	5
E7Y0	C1	CK 503	Capacitor, 0.05 μF, 50V	71590	1
C6X3	C2	TSD2-20-106	Capacitor, 10 μF, 20V	12406	1
C8W8	CR1	5003-002	Diode	03626	2
D5X1	CR2	5003-002	Diode	03626	REF
B1W2	CR3	1N4005/5CE6	Diode	04713	2
B0W3	CR4	1N4005/5CE6	Diode	04713	REF
E4Y0	F3	318.003	Fuse, 3AG, 3A, Slo-Blo	75915	1
D5X5	K1	AZ530-13-2	Relay, 6V	26806	1
D2U8	P1	86148-1	Connector	00779	1
C4Y4	Q1	TIP 32	Transistor	01295	2
D3Y4	Q2	TIP 32	Transistor	01295	REF
C3W4	Q7	2N3569	Transistor	01295	2
D9W5	Q8	2N3569	Transistor	01295	REF
E9W5	Q9	2N3645	Transistor	01295	2
E5W5	Q10	2N3645	Transistor	01295	REF
E6W3	R9	RC07GF152J	Resistor, 1.5K, 1/4W, 5%		1
C6W8	R10	RC07GF512J	Resistor, 5.1K, 1/4W, 5%		1
D5W7	R11	RC07GF752J	Resistor, 7.5K, 1/4W, 5%		1
D6W3	R12	RC07GF103J	Resistor, 10K, 1/4W, 5%		1
D4W4	R13	RC07GF473J	Resistor, 47K, 1/4W, 5%		2
C5X1	R14	RC07GF473J	Resistor, 47K, 1/4W, 5%		REF
D4Y0	R15	RC20GF150J	Resistor, 15Ω, 1/2W, 5%		1
D9W9	R16	RC20GF121J	Resistor, 120Ω, 1/2W, 5%		1
B1X7	T1	D302	Transformer	03626	1
B6W8	V1	1888	Lamp	71744	2
B7X2	V2	1888	Lamp	71744	REF

NOTE: With the Battery Option, Transformer D302 replaces Transformer D304 on the Main Board Assembly.

CHAPTER VI

RECOMMENDED SPARE PARTS LIST

PART NO.	DESCRIPTION	QTY.
LM301A	Amplifier	3
ET102X010P01	Capacitor	2
ET471X025A01	Capacitor	1
TSD2-20-106	Capacitor	2
1N4005	Diode	4
1N458	Diode	2
1N5248B	Diode, Zener	1
1N914	Diode	2
5003-002	Diode	2
5003-005	Diode	2
313.500	Fuse	2
361.010	Fuse	4
N7441B	Integrated Circuit	2
SN15830N	Integrated Circuit	1
SN7400N	Integrated Circuit	2
SN7420N	Integrated Circuit	1
SN7473N	Integrated Circuit	1
SN7490N	Integrated Circuit	2
CM26-305	Lamp, Indicator	2
39-66	Lamp, Indicator	1
76P-R200K	Potentiometer	1
R40-E061-1	Relay	1
PW162010001M	Resistor	1
PW162020001M	Resistor	1
PW162040600M	Resistor	1
PW162049500M	Resistor	1
35-44	Resistors -Matched Set	1

PART NO.	DESCRIPTION	QTY.
35-43	Resistor & Diode - Matched Set	1
TD101	Transistor	2
TD401	Transistor	1
TIP32	Transistor	1
2N3645	Transistor	3
2N3819	Transistor	1
2N3904	Transistor	4
2N3906	Transistor	3
2N4977	Transistor	1
5003-015	Transistor	1
40527	Triac	1
ZM1000	Tube, Indicator	2
	With Print Option - Add the Following	
5003-002	Diode	2
SN7400N	Integrated Circuit	1
2N3569	Transistor	1
	With Battery Option - Add the Following	
7.0 SCL	Cell, "NICAD"	5
1N4005	Diode	2
5003-002	Diode	1
1888	Lamp	2
D303	Transformer	1
TIP32	Transistor	2
2N3569	Transistor	1
2N3645	Transistor	1

APPENDIX

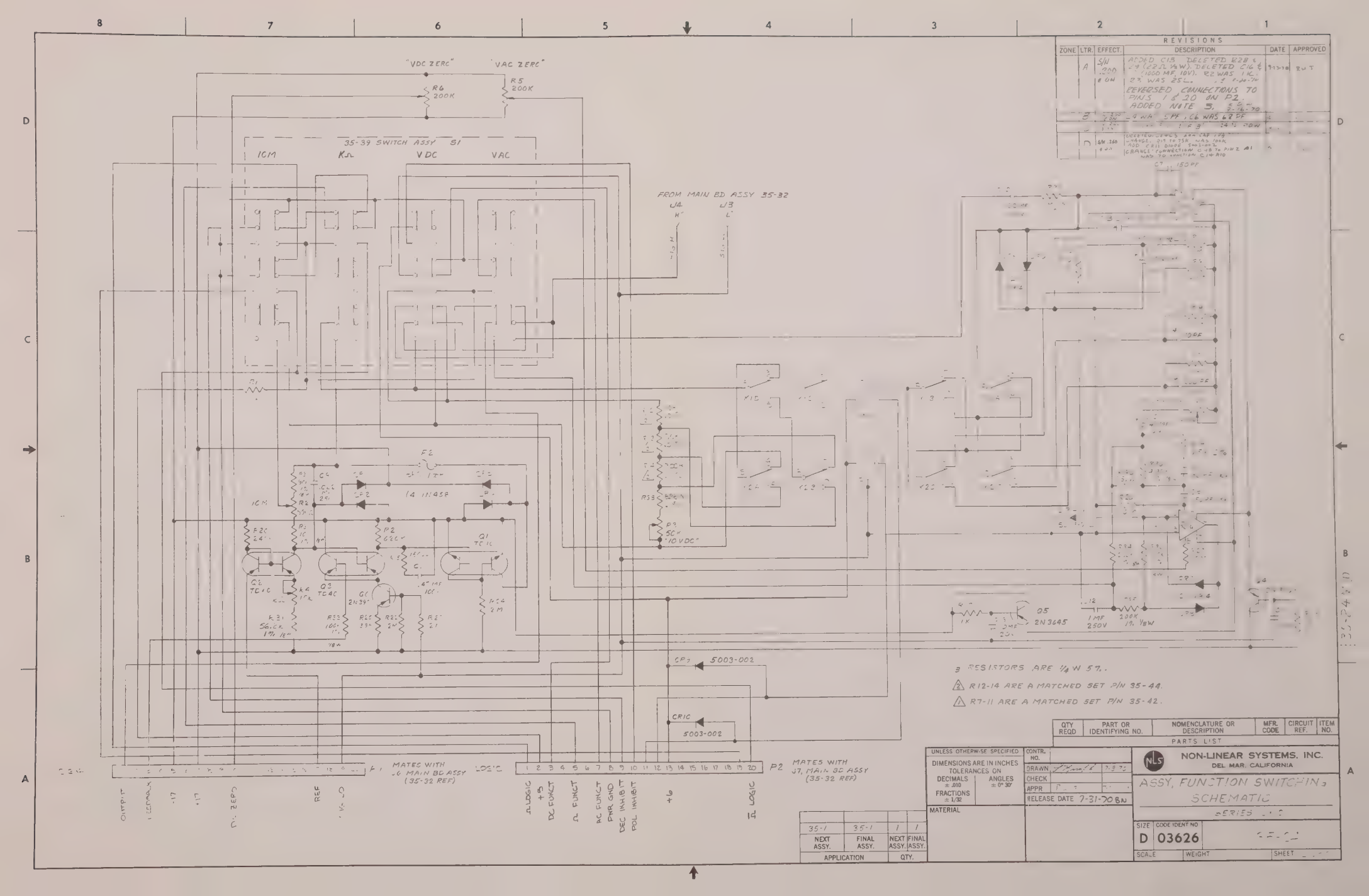
SHIPPING INSTRUCTIONS

Depending upon location, the choice of carrier will vary. Never ship an instrument to us without having received shipping instructions. If requested, an estimate of charges can be made before work begins.

Be certain to pack the instrument carefully; while an outer and inner box, separated by two or three inches of excelsior is desirable, the instrument can be placed into a single container provided it is so packed that it will not shift about. As with the double box method, use two or three inches of shock-absorbent packing materials. The instrument itself should be first wrapped in heavy paper so as to keep excelsior or other particles from entering the instrument's louvers. If the original shipping container is in good condition, it may be used.

CLAIM FOR DAMAGE IN SHIPMENT

The instrument should be tested as soon as it is received. If it does not operate or is damaged, a claim should be made with the carrier. The claim agent should receive a full report of damage, and this report sent to Non-Linear Systems, Inc. After receiving such a report we will advise you of the disposition of the instrument and arrange for its repair or replacement. Be certain to include model and serial number when corresponding.



3 RESISTORS ARE 1/4 W 5%.

2 R12-14 ARE A MATCHED SET P/N 35-44.

1 R7-11 ARE A MATCHED SET P/N 35-42.

REVISIONS

ZONE	LTR	EFFECT.	DESCRIPTION	DATE	APPROVED
	A	S/N 200 & ON	ADDED C13. DELETED R28 & R9 (22Ω, ¼W). DELETED C16 & C17 (1000 MF, 10V). R2 WAS 1K, R3 WAS 25Ω.	9-13-70	RWT
	B	S/N 300 & ON	REVERSED CONNECTIONS TO PINS 1 & 20 ON P2. ADDED NOTE 3.	2-16-70	
	C	S/N 326 & ON	R4 WAS 5PF, C6 WAS 68 PF		
	D	S/N 366 & ON	DELETED: C19 & C5 (.47μF, 50V). CHANGE: R15 TO 25K, WAS 100K. ADD: CR11 DIODE 1N4002. CRAWLE: CONNECTION C-49 TO R1N2 AT WAS TO JUNCTION C-49 R10		

QTY REQD	PART OR IDENTIFYING NO.	NOMENCLATURE OR DESCRIPTION	MFR. CODE	CIRCUIT REF.	ITEM NO.

PARTS LIST

35-1	35-1	1	1
NEXT ASSY.	FINAL ASSY.	NEXT ASSY.	FINAL ASSY.
APPLICATION		QTY.	

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES ON
DECIMALS ± .010
FRACTIONS ± 1/32
ANGLES ± 0° 30'

MATERIAL

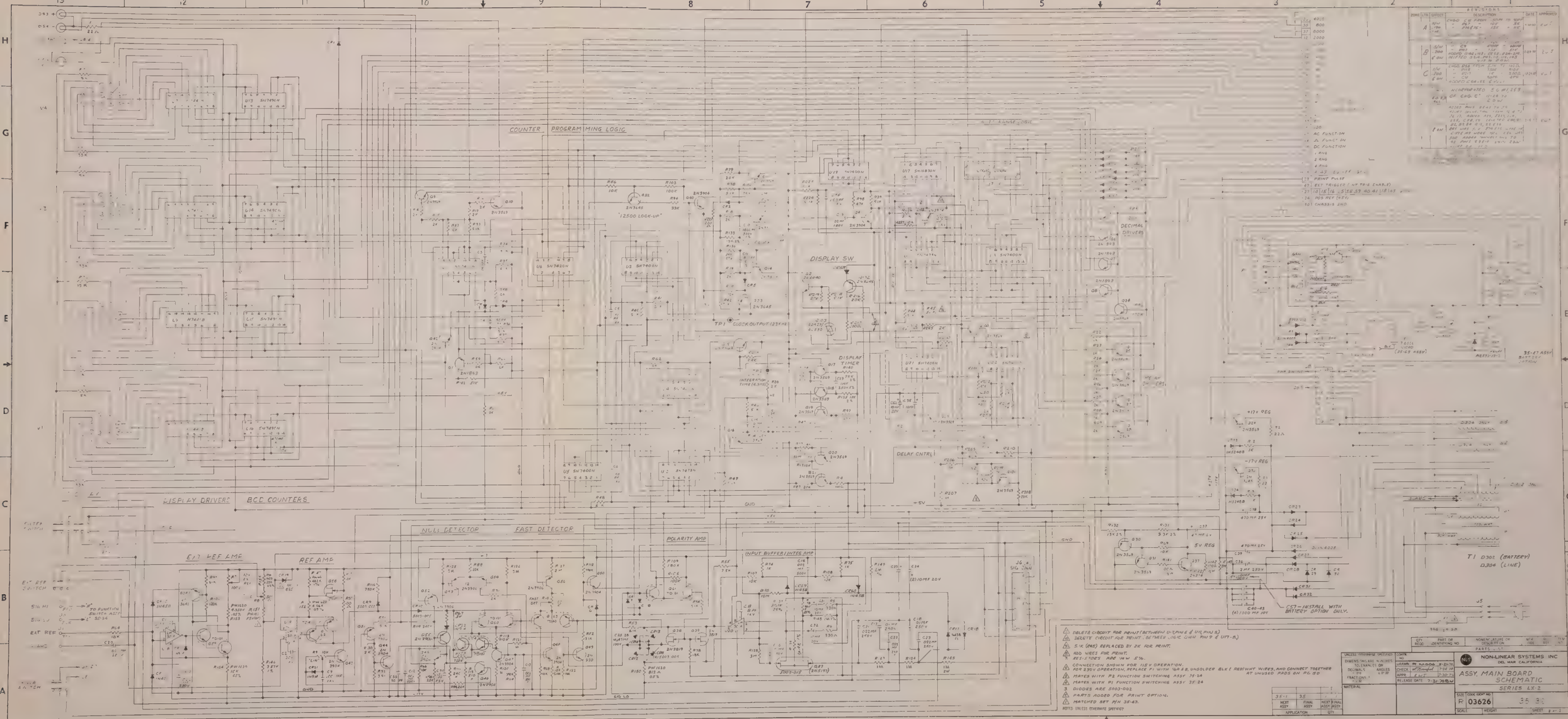
CONTR. NO.
DRAWN
CHECK
APPR
RELEASE DATE 7-31-70 BN

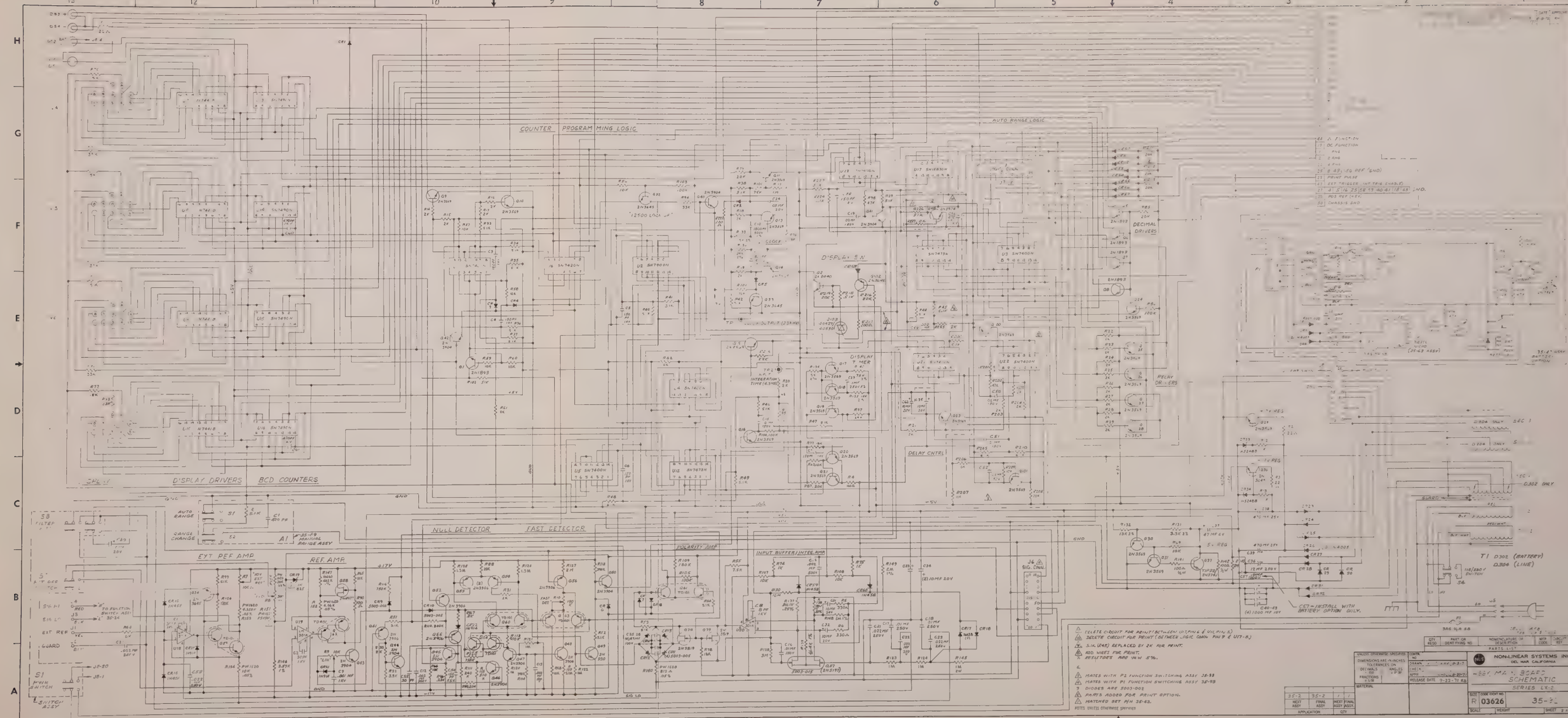
NON-LINEAR SYSTEMS, INC.
DEL MAR, CALIFORNIA

ASSY, FUNCTION SWITCHING
SCHEMATIC
SERIES [illegible]

SIZE	CODE IDENT NO	
D	03626	[illegible]

SCALE | WEIGHT | SHEET


COUNTER PROGRAMMING LOGIC
DISPLAY SW
DECIMAL DRIVERS
DISPLAY TIMER
DELAY CNTRL
DISPLAY DRIVERS
BCD COUNTERS
NULL DETECTOR
FAST DETECTOR
POLARITY AMP
INPUT BUFFER/INTEG AMP
EXT REF AMP
REF AMP
"12500 LOCK-UP"
TP1 CLOCK OUTPUT 125 KHz
INTEGRATOR TIME (4.3MS)
+17V REG
-17V REG
5V REG
T1 D302 (BATTERY)
D304 (LINE)
C40-45 (6) 1000 MF 10V
C27—INSTALL WITH BATTERY OPTION ONLY.
DELETE CIRCUIT FOR PRINT (BETWEEN U7 PIN 6 & U11 PIN 5)
DELETE CIRCUIT FOR PRINT. (BETWEEN LOGIC GND PIN 8 & U11-8)
5.1K (ONE) REPLACED BY 2K FOR PRINT.
ADD WIRES FOR PRINT.
RESISTORS ARE 1/4W 5%.
CONNECTION SHOWN FOR 115V OPERATION.
FOR 230V OPERATION, REPLACE F1 WITH 3AG 2.5 A SB, UNSOLDER BLK & RED/WHT WIRES, AND CONNECT TOGETHER AT UNUSED PADS ON PC BD.
MATES WITH P2 FUNCTION SWITCHING ASSY 35-54
MATES WITH P1 FUNCTION SWITCHING ASSY 35-24
DIODES ARE 2003-002
PARTS ADDED FOR PRINT OPTION.
MATCHED SET P/N 35-43.
NOTES UNLESS OTHERWISE SPECIFIED
NON-LINEAR SYSTEMS INC
DEL MAR, CALIFORNIA
ASSY. MAIN BOARD
SCHEMATIC
SERIES LX-2
F 03626
35 30
35-1
35


COUNTER PROGRAMMING LOGIC
AUTO RANGE LOGIC
DISPLAY DRIVERS
BCD COUNTERS
DECIMAL DRIVERS
RELAY DRIVERS
DELAY CNTRL
NULL DETECTOR
FAST DETECTOR
EXT REF AMP.
REF. AMP.
POLARITY AMP
INPUT BUFFER/INTEG. AMP
AUTO RANGE
RANGE CHANGE
S1 PWR SWITCH
SWITCH ASSY
TO FUNCTION SWITCH A2S1
EXT REF
GUARD
DISPLAY
TIMER
INTEGRATION TIME (4.3 MS)
DELAY
+17V
-17V
+5V
-5V
GND
T1 0302 (BATTERY) 0304 (LINE)
118/230 V SWITCH
CR1 - INSTALL WITH BATTERY OPTION ONLY.
J6 SIG. CONN.
P1
J1
J2
J3
J4
J5
J6
J7
J8
J9
J10
J11
J12
J13
J14
J15
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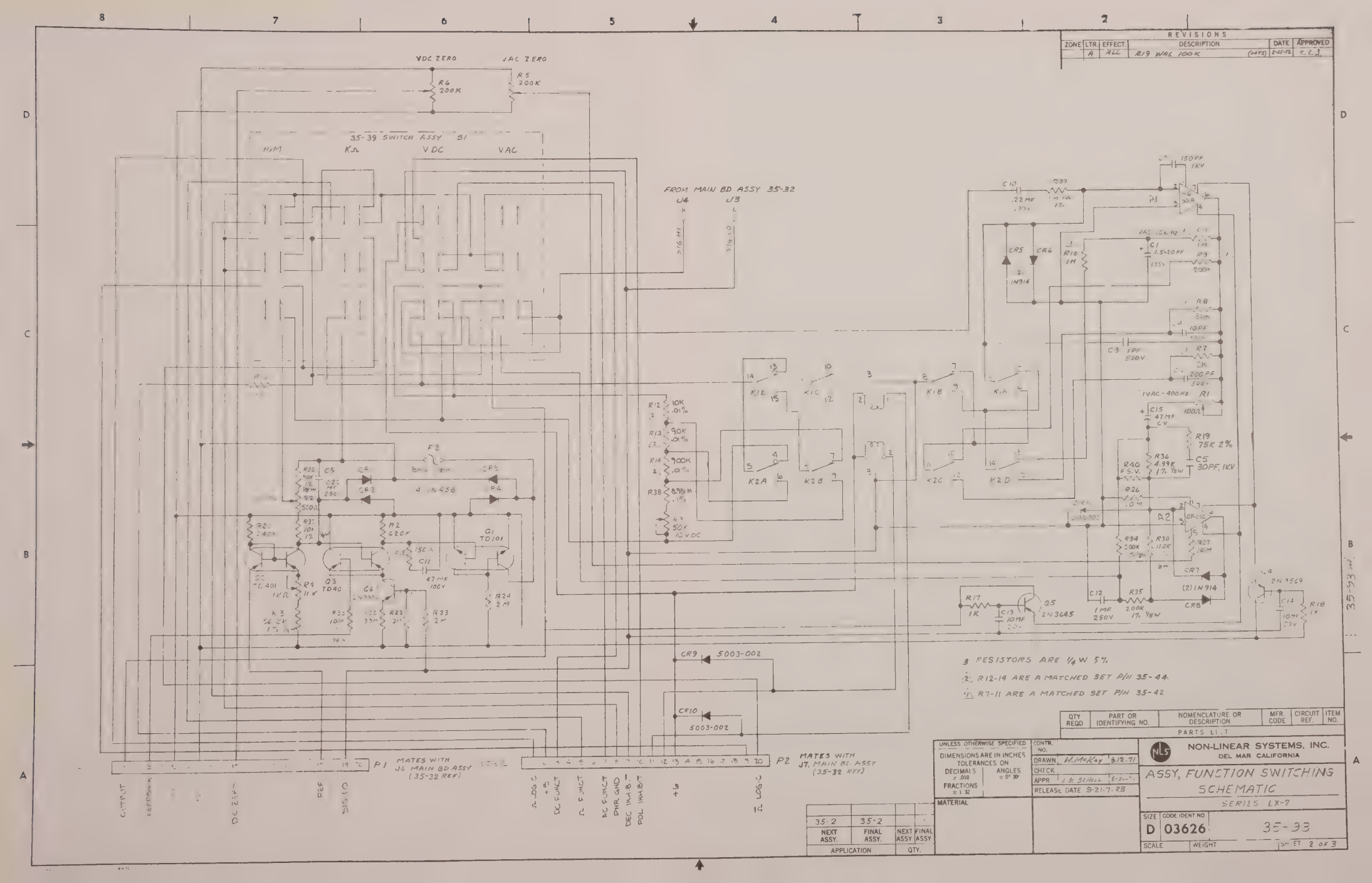
J40



3 RESISTORS ARE 1/4 W 5%

2 R12-14 ARE A MATCHED SET P/N 35-44.

1 R7-11 ARE A MATCHED SET P/N 35-42

ZONE	LTR.	EFFECT.	REVISIONS DESCRIPTION	DATE	APPROVED
	A	ALL	R19 WAS 100K (MFG)	2-15-72	C.C.J.

QTY REQD	PART OR IDENTIFYING NO.	NOMENCLATURE OR DESCRIPTION	MFR. CODE	CIRCUIT REF.	ITEM NO.

PARTS LIST

35-2	35-2		
NEXT ASSY.	FINAL ASSY.	NEXT ASSY	FINAL ASSY
APPLICATION		QTY.	

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES ON
DECIMALS ± .010
ANGLES ± 0° 30'
FRACTIONS ± 1/32

CONTR. NO.
DRAWN W. McKay 8.12.71
CHECK
APPR J. M. SCHELL 8-24-71
RELEASE DATE 9-21-71

MATERIAL

NON-LINEAR SYSTEMS, INC.
DEL MAR CALIFORNIA

ASSY, FUNCTION SWITCHING SCHEMATIC
SERIES LX-2

SIZE	CODE IDENT NO	
D	03626	35-93
SCALE	WEIGHT	SHEET 2 OF 3

35-93 Rev.

warranty

It is the continuous effort of Non-Linear Systems, Inc., to design and manufacture its products in such fashion as to at all times achieve the maximum customer satisfaction. Non-Linear Systems, Inc., issues this warranty in full recognition of its continuing obligation to its customers and its desire to always retain their respect and good will.

Non-Linear Systems, Inc., shall correct, either by repair or replacement, defects in material or workmanship in Non-Linear manufactured units or components where such defect develops within one year after delivery of the equipment to the original customer. In the instance of a defect of Sub-assemblies, Assemblies or Instruments manufactured by others than Non-Linear, every effort will be made to assist the customer in obtaining relief from the original manufacturer.

Any instrument claimed to be defective must be returned to Non-Linear Systems, Inc., Del Mar, California, transportation charges prepaid. The instrument will be repaired and returned to the purchaser, transportation prepaid, unless the instrument is found to be damaged by misuse, in which case the instrument will be returned to the purchaser with repair and transportation billed.

This warranty, being the entire agreement between the parties, is given expressly and in place of all other express or implied warranties including implied warranties for merchantability or fitness for particular use.

Non-Linear Systems, Inc.

SHIPPING NOTICE / PACKING SLIP

NOTE: This completed form must accompany shipment.

Date _____

Date of Original Purchase: ___/___ (Mo./Yr.)

Your Original P.O. No. _____

CUSTOMER SHIP PRE-PAID TO:

NON-LINEAR SYSTEMS, INC.
533 STEVENS AVE.
SOLANA BEACH, CALIFORNIA 92075

NLS RETURN(FREIGHT PAID)TO:

_____

_____

_____

Attn: _____

When using window envelope, fold here.

Description of Instrument and Accessories Included:

Instrument Model No. _____ P/N _____ S/N _____

Accessories _____ P/N _____ S/N _____

_____ P/N _____ S/N _____

_____ P/N _____ S/N _____

_____ P/N _____ S/N _____

_____ P/N _____ S/N _____

_____ P/N _____ S/N _____

_____ P/N _____ S/N _____

Reason for Return (specify malfunctions in detail):

_____

_____

_____

_____

_____

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_____

NLS Form 200-50

NOTICE

If at any time it should become necessary to return an NLS instrument to the factory, follow the instructions contained in the Appendix of this manual (page A-1) and utilize NLS Form No. 200-50 (Shipping Notice/Packing Slip), located at the rear of the manual.

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